Analysis of selected agricultural projects in the middle east: with particular reference to Tauorga, Libya

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ANALYSIS OF SELECTED AGRICULTURAL PROJECTS IN THE MIDDLE EAST: WITH PARTICULAR REFERENCE TO TAUORGA, LIBYA

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To

my wife Sana

my son Amir

my brother Yousf

and to the memory of my parents

ABSTRACT

It is clear that the increasing of agriculture productiveness is essential to economic development, but this involves special problems arising from the distinct characteristics of agriculture itself and of its relations with the other sectors of economy and society. Ultimately, all agricultural development policies (as all other policies), have to be implemented at project level, and the evaluation of the factors affecting the degree of success achieved in such projects is of obvious importance.

In this thesis attention is restricted to a consideration of agricultural development projects in the Middle Eastern arid zone. The Tauorga project in Libya is analysed and evaluated in depth and particular attention is paid to identifying the technical or non-technical problems and difficulties which hindered this project's progress. From this, a geographically based approach comprising three types of evaluation is derived. These three types of evaluation are: critical path analysis; application of the law of the minimum; suitability and interdependence of input factors.

Two further analogous agricultural projects in the U.A.E. and Oman, which are described in some detail, are also examined by means of applying these evaluation methods. A further three analogous agricultural projects, all in Saudi Arabia, are more briefly described, and judged against original proposals in the light of the results obtained from the previous more detailed studies.

It is concluded that the approaches used here for analysing project performance could be valuable tools for improving project design and implementation through feedback and forward control systems.

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INTRODUCTION

Enormous investments are being made in improving existing farming, introducing new virgin lands into cultivation and measures to conserve soil and water resources etc. Remarkably important are the construction of large, advanced technology, commercial agricultural projects, particularly in Libya and Arabia, during the last few years aimed at settling or resettling inhabitants and aiming to achieve the improvement of the socio-economic and cultural life of the inhabitants.

In all these projects real agricultural potential exists, but the physical environments are harsh and given the need for the commercial viability of these projects, the exploitation of this potential demands the use of non-indigenous technology throughout, from the feasibility study phase all the way through to the production and marketing phase.

It was very easy for these countries to pay for the import of technology and technical skill because of their abundant capital, and to some extent they have succeeded in this. This success, however, has not extended into project implementation and, in particular, did not continue when the question of operating these high technology projects and maintaining them arose.

In spite of the poor technological background of these countries, and partly because of the relatively difficult physical environments they chose the implementation of a highly technical approach, which requires highly skilled operators, workers and trained settlers/agricultural workers etc.

Since very few, or even no human preparations or changes took place to match this requirement demand, the projects did not operate as they were planned, as we shall see in the case studies.

During the 1960's, the German Consulting Engineering Group and the West German engineering consultants, WAKUTI, were engaged in extensive development work in the Third World. In April 1973 the author joined the first firm as an agronomist. After a few days in the branch office at Tripoli, Libya, was sent to Kufra, South East of Libya, where the firm was involved in studying, investigating and planning an irrigation and semi-nomadic settlement project. At Kufra settlement project the author's assignment, with another German expert, was to carry out a socio-economic survey of the area. This involved detailed research into family incomes, family expenditure, family size and their willingness to become settlers etc.

The author was also involved with soil sampling, analyses and permeability trials as well as with the surveying work. Later this firm was involved in Um Al Jdawl, Wadi Shatti, and Sebha and again the author was involved with the same activities and, in addition, served as assistant to a well drilling expert.

In June 1975 the author joined WAKUTI firm, as an agronomist at Tauorga Agrarian Reform project where he was involved with the supervision of the levelling, leaching and reclamatory cultivation. In addition he also acted as an interpretor in meetings with the Libyan authorities. From April 1977 to December 1977 the author continued to work in this project on behalf of the Libyan Tauorga project supervision committee when he was completely responsible for the management, organization of the seasonal and daily agriculture processes, irrigation and labourers in Area South, 414 ha. in size,in this project. In the course of his four and a half years in Libya, the author travelled extensively in the country, and formed a broad picture of the current agricultural situation.

During 1980 a research fieldwork programme in Libya was planned, with the assistance of the Society for Libyan Studies, but had to be abandoned because an entry visa could not be obtained. This study is therefore based on: (a) the author's own work experience and independent investigations carried out during employment in Libya, (b) the largely unpublished reports and documents produced in and for Libya by government agencies and consultants, (c) other documents and reports relating to projects elsewhere and (d) the more general studies noted in the bibliography.

In Chapter One a brief agricultural background of Libya is reviewed.

Chapter Two comprises studies of location, history, land use and land tenure relating to the Tauorga project.

In Chapter Three the physical factors of terrain, climate, soil and water involved in the project implementation are described.

In Chapter Four the economic, social and organizational factors of production are examined in the context of the land factors considered in Chapter Three.

Chapter Five comprises two parts:

Part One covers the development processes of the project, while

Part two covers the project objectives, paying particular attention to the planned family income of the settlers. The hypothetical profitability of the proposed family farms can only be estimated by utilizing relatively simple analytical methods because of the lack of availability of data necessary for a more sophisticated analysis.

In addition, a circle of development is identified.

In Chapter Six the technical and non technical problems and difficulties which hindered the project progression leading to wide discrepancies between plan and actuality are identified and analysed.

In Chapter Seven a fundamental and typological review of the reasons for such discrepancies between planned actuality is analysed. Consequently a hypothetical and geographically based approach is derived, this comprising three evaluation elements; these are ;

1. Critical path analysis
2. Liebig's concept of "Law of the minimum"
3. Matrix analysis of the suitability and interdependence of the input factors involved in the project development.

In Chapter Eight these three criteria are applied in analysing another two analogous agriculture projects, which are described some in detail, these are -

1. The Tawi Mileiha project in United Arab Emirates.
2. Kamil Al Wafi project in Oman.

Furthermore, another three analogous agricultural projects, all in Saudi Arabia, are briefly described and are judged against original proposals in the light of knowledge built up from those examined earlier. These are - 1) Ain Haradh, 2) Al Hassa Oasis and 3(Qatif.

In Chapter Nine, the Conclusion, following the earlier testing of the suitability of the evaluation approaches developed in Chapter Seven, the application of these evaluation techniques <u>during</u> rather than <u>after</u> project work is explored. It is concluded that, through the feedback and feedforward of information, the result of applying these evaluation techniques at all stages would significantly improve the development process even though in some cases there may be implied major changes of policy.

CHAPTER ONE

1.1 Introduction and Background

At the time of its achievement of independence in 1951, Libya was considered to be one of the poorest countries of the world, with few known natural resources, a difficult natural environment, and a population which was small, poor, illiterate and backward in almost every respect.(1) The people had endured considerable hardships under Ottoman rulers who governed the country between 1551 - 1911, and Italian rule from 1911 to 1943. Education had been almost completely neglected and what economic development had been encouraged had been largely for the benefit of the foreign colonisers. To be sure, the Italians had left a number of good farms in various Italian settlement schemes and a significant physical infrastructure, mainly serving the coastal areas, much of which, however, was destroyed during the second world war. No effort had been made to unite the various settled parts of the country, which were separated by difficult country and hundreds of kilometres of desert.

On independence, therefore, the economy was in poor shape and depended on outside aid. Table No. 1.1 shows the amounts of outside financial aid given by foreign governments.(2)

The resources of the country simply were not then adequate to support the very large investment needed to construct the transport and communication links required to unify the country geographically, or to create the educational and health facilities required to develop the native abilities of the people, or to build the foundations for a productive and growing agriculture and industry.

TABLE NO. 1.1 Financial Aid given Libya by Foreign Governments

Country	Amount	Remarks
British	400,000 L.D.	1952 - 1953
	1,000,000 L.D.	1953
	3,250,000 L.D.	per year for Libyan budgetary support in return for certain military privileges with no additional contribution for development (in 1958)
French	200,000 L.D.	1952 - 1953
Italy	600,000 L.D.	1952 - 1953
United Nation LATAS and other	1,200,000 L.D.	LATAS = Libyan American Technical Assistance Services
United States	7,000,000 $	1954
	4,000,000 $	per year 1954 - 1960
	10,000,000 $	per year 1960 - 1965
Other Countries	100,000 $	

In an average year such as 1950, the following (Table No. 1.2) indicates the volume of crop production and number of livestock.(3)

TABLE NO. 1.2 Average crop production and number of livestock, 1950

Crop	Metric tons	Animals	Number
Barley	85,000	Sheep	767,000
Wheat	8,000	Goat	690,000
Dates	40,000	Cattle	63,000
Olive oil	8,000	Camels	83,000

While there are no reliable figures on the annual livestock production in terms of meat, milk, wool and hair, it can be safely assumed that per capita output was very low, due to poor breeding, feeding and management conditions.[4] Table No. 1.3 shows the different sources of national income in 1959 where the agricultural sector contributed an estimated 24.5 per cent of the Libyan national income.

TABLE NO. 1.3 Distribution of National Income by source, Libya 1959

Source of income	% of total income	National income (000 L.D.)
1. Agriculture	24.5	13,750
2. Petroleum Prospecting	7.7	4,300
3. Manufacturing and Repairing	11.4	6,406
4. Construction	3.5	2,000
5. Electricity and Gas	1.5	837
6. Transportation, storage and communication	7.3	4,072
7. Wholesale and Retail trade	14.3	8,024
8. Banking and Insurance	2.5	1,383
9. Ownership of Dwellings	8.9	5,000
10. Public Administration and Defence	13.7	7,700
Other services	4.7	2,640
Total	100.0	56,112

Source: United Kingdom of Libya, Statistical Abstract of Libya 1958-1962 (Tripoli 1963)

The economy had indeed, despite appearances, been undergoing a slow change since independence.[5]

Before the discovery of oil the physical resources that could be identified for development were agriculture, fisheries and tourism, in this order of priority.[6] At that time nearly 80% of the population lived in the rural and nomadic sectors of the economy and most the labour force was engaged in these sectors. Apart from the few modern farms, which were largely owned and managed by Italians, the agriculture of the country was in the subsistence sector, except for cereals and livestock, of which there were significant marketable surpluses in some years. Agricultural production was largely determined by amounts of rainfall, which is very unpredictable. Three main types of farming could be distinguished in the pre-oil period[7] - a) Nomadism, b) semi nomadism and c) settled farming.

a) Nomadism:- A nomad is primarily dependent upon grazing flocks of sheep, goats and camels. The distinguishing feature is that nomads will leave their tribal centres for long periods and venture out into the desert in search of rainfed natural grazing. They may remain there for several years grazing their flocks and sowing small quantities of grain (mainly barley). There is often no regular pattern to their movement (within acknowledged territories) because their livelihood is dependent upon rainfall in the desert area which is unpredictable and unevenly distributed. Since the nomads are wanderers in isolated areas, they are generally illiterate and their health and living conditions are poor.

b) Semi-nomadism:- This involves farming of permanent plots of unirrigated land together with regular annual patterns of pastoral migration. By the middle of September the semi-nomads leave their farm land and move over several kilometres to the oasis or coastal areas to buy dates (or to collect dates from their own oasis trees) and other food stuffs After about eight weeks they return to plough and sow their land with barley and wheat. From December until May they simply move their tents over the grazing range in search of food for their animals. Toward the end of April - beginning of May the harvest begins and this keeps them occupied for about two months. Thus the semi-nomads roam, but within a confined area and in relatively regular patterns. Here also agricultural techniques are simple, literacy low and although social and economic organisation of life was more complicated than that of the full nomads, the subsistence aspect was still dominant and the production of products for sale or exchange remained low. The inhabitants of the Tauorga oases region were essentially semi-nomads of this kind.

c) Settled farming:- Most of the settled farming was located in the Western Region of Libya, mainly along the coastal plain. Two types of settled farming must be identified. The first was the traditional Arab farm. This usually consisted of a small plot of intensively cultivated irrigated land. Most of the output was used for the farmers personal consumption. Some farmers also owned animals which were grazed on the unirrigated areas. Others owned individual sections of dry land which were visited twice a year, once in November to plant the crop and again in May to harvest. For the remainder of the year, the Arab farmer worked on his irrigated plot.

The second type of settled farming consisted primarily of the former Italian concession and demographic settlements.

These were larger farms who generally utilized modern machines and methods. Many were irrigated with efficient pumping and distribution system. In many cases they were still run by Italians up to the late 1960's and production was carried out with the aim of making a profit through sales on the open market.

In fact there was substantial seasonal unemployment and permanent under-employment in agriculture and nomadic activities.(8)

Yet, in spite of such a poor state of development, agriculture was the backbone of the economy. It engaged about 70% of the active labour force and produced about 60% of the gross domestic production.

Except for scrap metal remaining from the second war, exports in the 1950's consisted of agricultural produce including esparto grass. These facts pointed to the necessity of giving agriculture development priority.(9) But the implementation of such a strategy was handicapped by the extreme shortage of skill in agriculture and the scarcity of capital. Infrastructure was almost entirely lacking in the rural areas and was badly damaged during the war in urban areas. Moreover, the Italians did little or nothing to prepare the Libyan people for self-government. Education and technical training were neglected, and the Libyans were virtually excluded from the administration. As a result, through no fault of its own, Libya has remained heavily dependent on foreign administrative and technical personnel, and the training of Libyans to replace them is still the most difficult of all the problems associated with economic development.[10]

This bleak picture was dramatically changed with the discovery and development of the country's oil resources. Independent Libya turned its attention to the problem in the early 1950's, and late in 1953 oil exploitation permits were issued. Activity effectively got under way in 1955 after the first petroleum law was signed in June and the first concessions granted in November. Four years later oil had been discovered, and by 1961 exports had begun. In 1962 the Libyan government received over L.D 14 million in oil revenues.[11]

The discovery of oil in Libya and the subsequent rapid exploitation of reserves is the most important economic and social factor to affect Libya since the Italian colonial occupation of the country after 1911. National and per capita income have been rising rapidly since 1962 and the impact of this new wealth has been felt very much in the agricultural areas of the country. The trade sector and the construction and service industries, and the high wages offered by the urban sector, brought about by the discovery of oil,[12] all resulted in the movement of labour and capital away from agriculture. With this movement, Libyan agriculture was left to stagnate in its low level of development, and the consumer turned to world markets for the purchase of his food supplies.

The availability of food from abroad filled the gap created by the sudden increase in demand in the cities. Many people tended to look upon this source as an adequate and relatively easier alternative to the development of domestic agriculture. Thus, gradually, the urban, and later on even the rural population, became more and more dependent upon foreign agriculture for the production of its food requirements.[13] It is clear, as we can see from Table No. 1.4, that there were significant shifts taking place, including also a decline in the percentage of the economically active population in agriculture, falling significantly between 1958 and 1964 by 36.21% while the percentage of the economically active population in the other sectors increased.

TABLE NO. 1.4 Percentage of economically active population, 1958 and 1964

Division of economic activity	% of Total	
	1958	1964
Agriculture, Forestry, Hunting and Fishing	71.95	35.74
Mining and Quarrying	1.28	3.52
Manufacturing	4.55	7.25
Construction	1.83	7.76
Electricity, gas, water and sanitary services	0.35	1.50
Commerce	5.15	6.60
Transport, communication and storage	2.64	5.61
Services	12.25	20.36
Activities not adequately described		11.66

Sources: United Kingdom of Libya, National income estimates, 1958; and Kingdom of Libya, General population Census, 1964. (Tripoli)

Between 1958 and 1962, during the first years of the oil era, the status of agriculture declined in every possible way.

It is obvious in Table No. 1.5 that the worst impact of oil on agriculture production was during the period 1958 - 62 when the absolute value of agriculture income, at 1964 prices, declined from L.D 20 to 17.3 million.

TABLE NO. 1.5 Economic Indications of the changing Status of Agriculture (L.D.million)

National Economy	1958	1962	1967
Total value of agricultural production (1964 prices)	20.0	17.3	21.0
Value of food exports (current prices)	2.7	1.8	0.6
Value of food imports (current prices)	5.1	8.4	19.2
Food deficit (value)	2.4	6.6	18.6
Value of petroleum exports	0	49.0	417.3
Per cent			
Value of petroleum production as per cent of GDP	6.9	28.5	54.7
Value of agricultural output as per cent of GDP	26.1	9.4	3.4
Agricultural Labour (per cent of total labour force)	70.0	50.0	33.9

Source:- Allan, J.A. et al Libya: Agriculture and Economic Development, (London, 1973), p.16.

The trend however was reversed between 1962 and 1967 as production at constant prices increased from L.D. 17.3 to 21.0 million. That reversal was due to the intensified efforts to diversify and to upgrade the efficiency of agriculture production, this in turn made necessary by the rising dependence on food imports. As from 1969 a new income tax law was decreed which gave agricultural employees and the agriculture sector considerable exemptions from income tax payment. Also were established loans and subsidies to farmers to modernize their production methods and buy agricultural machinery, or dig wells and develop irrigation, and to breed pedigree animals such as Friesian cows, which were imported and sold at half price, etc.

Furthermore, Five year plan (1963-1968) investment allocations were introduced in an attempt to rescue agriculture, as shown in Table No. 1.6.

TABLE NO. 1.6 Five Year Plan 1963 - 1968 - Summary Programme for Agriculture

Project	Estimated Cost 000 L.D.
1. Agriculture settlement	10,000
2. " marketing	3,500
3. Development of water resources and soil conservation	3,500
4. Heavy and light agriculture machinery	2,500
5. Forest and range development	2,000
6. Animal health development	1,500
7. Agriculture extension	800
8. Horticulture	500
9. Plant disease and pest control	400
10. Agricultural research and experiment	700
11. Agriculture statistics	75
12. Agriculture credit	3,800
Total	29,275

Source:- Kingdom of Libya, Five-year Economic and Social Development Plan, 1963-1968 (Tripoli, 1968), p.77.

From oil discovery onward there was no looking back; production rose from less than a million tons in 1961 to over 125 million in 1969 and revenues exceeded L.D. 270 mn.

Libya became the third largest producing country in the Middle East, the sixth in the world. Per capita income increased ten or twelve times, roads and airlines spread across the country linking it together, schools and school enrolment increased very rapidly, and the main centres of the country became hives of bustling activity.[14] Since the base of economy, before oil, was agriculture, it was natural that the economic impact of oil would be felt most acutely in that sector.

There was a lack of essential technical and economic data needed for the formulation of adequate agriculture development projects. Shortage of technical know-how, as well as the lack of adequate government machinery to formulate and execute co-ordinated national agriculture plans which made it extremely difficult to progress quickly in that direction.[15] However, a start was made and some progress was achieved in introducing the essential elements of modern agriculture among the rural people.[16]

Since 1970 the agriculture development sector has received considerable sums of investment as shown in Table No. 1.7 and the green revolution through turning conventional agriculture into modern and mechanised farming was announced.[17]

Table No. 1.7. Capital Allocation for Agriculture

Year	Ordinary	Development	Remark
1970/71	6.7	23.4	L.D. Million
1971/72	7.4	47.9	
1972/73	8.9	63.2	
	Agriculture and Agrarian Reform*	Integral Agricultural Development	
1973/75	244,400	326,145	L.D.Thousands
1975	103,700	131,000	
1976	111,586	226,840	
1977	104,110	176,050	
1978	109,000	227,600	

Source:- Mclachlan, K.S. Petroleum and Development in Libya, University of Durham (February 1978)

From October 10th 1972 (19) onwards the responsibility for the development of agriculture in Libya lay mainly with two main types of agency. First, the Council of Integrated Agricultural Development, which since December 1978 is called the Secretariat for Land Reclamation and Settlement (20) is responsible for the survey of land, water and other natural resources for agriculture, for conservation, for the selection of specific areas for agricultural development and for the first phase of development implementation including

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* Established in January 1970 (18) to replace the Ministry of Agriculture, Forestry, Hunting and Fishing.

basic agricultural infrastructure.

Secondly, the Ministry of Agriculture and Agrarian Reform, which since December 1978 is called the Secretariat of Agriculture, is responsible for the improvement of existing agriculture and for the production phase of projects established by the Secretariat for Land Reclamation and Settlement. The detailed objectives of these two Secretariats can be summarized as follows:-

Objectives of the Secretariat for Land Reclamation and Settlement are [21]:-

1. Protection of natural resources against erosion and damage.
2. Improving pastures.
3. Exploitation of available surface and underground water.
4. Exploitation of arable land in order to create settled communities, this includes the following:-
   1) Identifying, studying and adopting of areas for implementation.
   2) Land reclamation and development.
   3) Building farmers' houses.
   4) Drilling production wells and dam construction.
   5) Construction of irrigation and drainage canals.
   6) Paved roads.
   7) Planting fruit trees.
   8) Planting windbreaks and forestry.
   9) Farmers' training

There are five regions of agriculture development in Libya (Table No. 1.8) which are being operated by the Secretariat for Land Reclamation and Settlement.

TABLE NO. 1.8 Regions of Agriculture Development in Libya

Region of Development	Cultivated area/ha.	
	Irrigated	Fallow
The Gefara plain	22,898	90,472
Jabal Akhdar	25,215	172,599
Fezzan, Sebha	27,280	-
Kufra and Sarir	49,900	-
Solol Khdar	29,850	18,802
Total	155,143	281,873

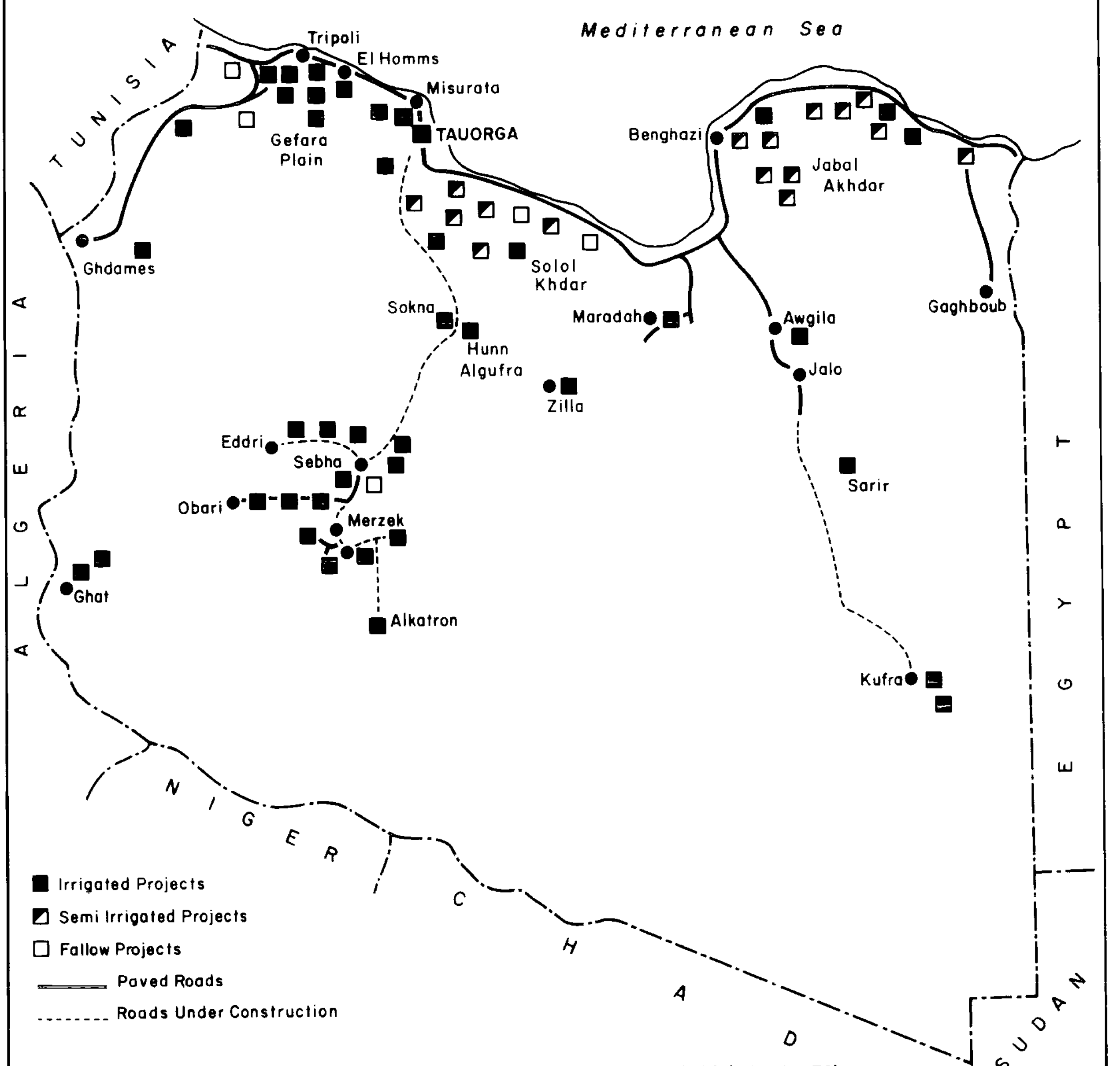
Source:- Arab League, The Arab Nutrient Security Plans, (Khartoum 1980), p.1291.

Fig. No. 1.1 indicates the development of the agriculture sector in these five regions, during the plan 1976-1980.

Objectives of the Secretariat of Agriculture:-[22]

1. Issuing agricultural acts and legislation.
2. Establishing agricultural banks and agricultural co-operative societies.
3. Improving seed strains of cereal crops, vegetables, fruit trees, and animal husbandry i.e. cattle, poultry, sheep, and bees which are suitable for the areas and have a high yield.
4. Extension and services for plant and animal production.
5. Plans for plant and animal protection i.e. disease and pest control.
6. Mechanization of agriculture. Carrying out the agrarian reform works through The General Administration for

Fig 1·1 AGRICULTURE SECTOR DEVELOPMENT, LIBYA, 1976-1980



Source: Libyan Ministry of Planning, The Socio-Economic Transference Plan, 1976-1980 (Tripoli, 1976)

Agrarian Reform established on February, 5th, 1974.[23]

7. Training the farmers how to use and maintain agriculture machinery and giving import permits.

8. Importing of required cereals and fodder.

9. Carrying out the scientific agriculture research through The Agriculture Research Centre, established in 1971.[24]

In general terms, therefore, we have to note that objectives of any development project since October 10th, 1972 are laid down by the Secretariat for Land Reclamation and Settlement but the production responsibility becomes that of the Secretariat of Agriculture.

In the case of Tauorga, the project objectives (see p. 154) were first established during the 1960's under the then Ministry of Agriculture, Forestry, Hunting and Fishing. The sequence of subsequent operations at Tauorga is described in Chapter 2.

As far as farming finance in Libya is concerned, agricultural banks and other institutions have been established in order to subsidise and support the agricultural sector, as a step to promote this sector towards progress. Nationally the situation is as follows:-

Agriculture Banks[25]

Agricultural banks are one of the agricultural finance institutions in Libya which supply the necessary facilities both for the farmers and for the agriculture co-operative societies in the form of interest free loans and subsidies.

There are three types of loan:-

I. Short term loans

To make available seeds, fertilizers, chemicals, fuel employment of labour, poultry farming and bee-keeping.

The farmer has to pay back the loan within a year.

II. Medium term loans(26)

This type of loan is given for buying agriculture machinery such as tractors, ploughs, engines, generators, pumps, pipes, seed drills and harvesters, etc. Also dairy cattle, bees and equipment, including trucks (for the co-operative societies).

The farmer has to pay back the loan within four years, but within five years for the co-operative societies.

III. Long term loans(27)

This type is given for establishing, developing or completing farm schemes, including drilling wells, canals and reservoir construction; construction of granaries, farm fencing; tree cultivation; levelling and preparing the soil; establishing poultry farms either for meat or eggs.

The farmers have to pay back the loan within fifteen years starting from the sixth year of loan but with poultry for meat starting after the second year of the loan and with poultry for eggs after two and a half years of the loan i.e. twice yearly instalments.

Table No. 1.9 shows the amount of Libyan Dinars and number of farmers involved in these loans.

TABLE NO. 1.9

Type of Loan	Period from 1.9.1969-31.7.1976	
	L.D.	No.of farmers loaned
Short term loan	25,151,160	121,454
Medium term loan	21,629,016	37,088
Long term loan	19,289,664	13,652

Source:- Libyan Ministry of Agriculture and Agrarian Reform, Achievement of the Revolution, Sept. 1969 - Sept.1976, (Tripoli), pp.178-182.

The Government knows that the farmer is too weak to stand on his own feet unless he is supported. So the Government has subsidised the farmer as shown in Table No. 1.10.

TABLE NO.1.10 Governmental Subsidies, August 1970 - 30 June 1976.

Type of Subsidy	L.D.
Chemical fertilizers	9,573,914
Chemical Pesticide	214,710
Fodder	33,190,458
Agricultural Machinery	14,079,607
Electricity supply for farms and farmhouses	2,271,940
Hydro projects	3,415,573
Farmers' grape marketing	23,816
Bee equipment	143,123
Fencing and roads	164,271
Total	63,077,412

Source:- Libyan Ministry of Agriculture and Agrarian Reform, Achievement of the revolution, Sept. 1969-Sept.1976, (Tripoli, 1976), p.184.

The Ministry of Agriculture and Agrarian Reform issued an Act No. 47 for the year 1971 in which all farmers all over the Republic have to be members of agriculture co-operative societies. The society has to supply the following for its members:-

1. Fertilizers, seeds, fodder and agricultural machinery.
2. Machinery services such as levelling, ploughing and harvesting.
3. Facilitating the securing of loans and agricultural support from the agricultural banks.
4. Marketing the agriculture production.
5. Establishing workshops for maintaining the machines.

The following Table No. 1.11 shows the number of the agricultural co-operative societies:-

TABLE NO. 1.11 Number of Agricultural Co-operative Societies

Year	No.	Remarks
1965	83	
1966	90	
1967	98	
1968	111	
1969	41	The reason for decline in the numbers is that any society unable to provide services for its members had to be disbanded.
1970	90	
1971	74	
1972	74	
1973	91	
1974	159	
1975	179	
1976	190	

Source:- Libyan Ministry of Agriculture and Agrarian Reform, Achievement of the revolution, Sept. 1969-Sept.1976. (Tripoli, 1976), p.15.

The background to agricultural project development has been described briefly in this introductory section. In particular, we have to note that since the early 1960's revenue from oil production and export made planned government investment in agriculture on a large scale theoretically possible. However, it was not until the deterioration in the status of agriculture, which resulted from the vast expansion of oil income, imports and even more rapid urbanisation that major attention was paid to large scale rural development. This has accelerated during the 1970's with the formulation of policies attempting to limit the volume of oil production and encouraging centralised state-planning of other resource exploitation.

Out of about 176 million ha. of the total area of Libya, there are about 3.8 million ha. arable land, i.e. 2.159%, but only 1.8 million ha. are under cultivation i.e. 1.215 million ha. depend on rainfall and 155,000 ha. under irrigation.[28] Only 4.07% of the arable land is under irrigation and consequently the Tauorga project share is approximately 0.078%.

The Tauorga project, first conceived during the early 1960's is now part of this contemporary approach. In brief, the main objectives of what became the Tauorga Agrarian Reform Project, are as follows:-

1. The reclamation of a net 2283 ha. of unutilised land and its conversion to irrigated land, this to be divided into 300 farms for distributing to farmer-settlers. This distribution to be carried out when blocks of reclaimed land are

judged to be in a physical condition suitable for cultivation according to the High Planning Council recommendations.

2. To develop the socio-economic and cultural life of the rural society in the region.

3. The participation in increasing the flow of agricultural products to the national market.

More detailed consideration of project objectives, and the relationship between these and project implementation, is given in Chapter Five.

1.2 Thesis Objective

In this thesis the first aim is to investigate the progress of the Tauorga Agrarian Reform Project so as to identify technical or other problems which hindered that progress. Secondly, to examine and classify the nature of these problems so as to derive from analysis some principles of and approaches to evaluating project progress at Tauorga. Thirdly, to apply such approaches to other analogous projects in order to test their more general validity. Lastly, to explore the possibility of building such approaches into the development process with the aim of improving development results.

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CHAPTER TWO

TAUORGA AGRARIAN REFORM PROJECT

2.1. Location and General Description of the Project area.[1]

The irrigation area of Tauorga Agrarian Reform project stretches along the Misurata-Sirt main road, between the coastal ranges and the Bay of Sirt, Fig. No.2.1.1.

It lies nearly 35 km. away from the coast of the Mediterranean Sea and approximately 10-20 m. above sea level.

Of the 8,000 ha. first surveyed in 1960 only the best 3,000 ha. of arable land was chosen for irrigation, in approximately a square area (see Fig.3.2.1). The gross area of the project included a planned net area of agricultural land, of 2,284 ha.

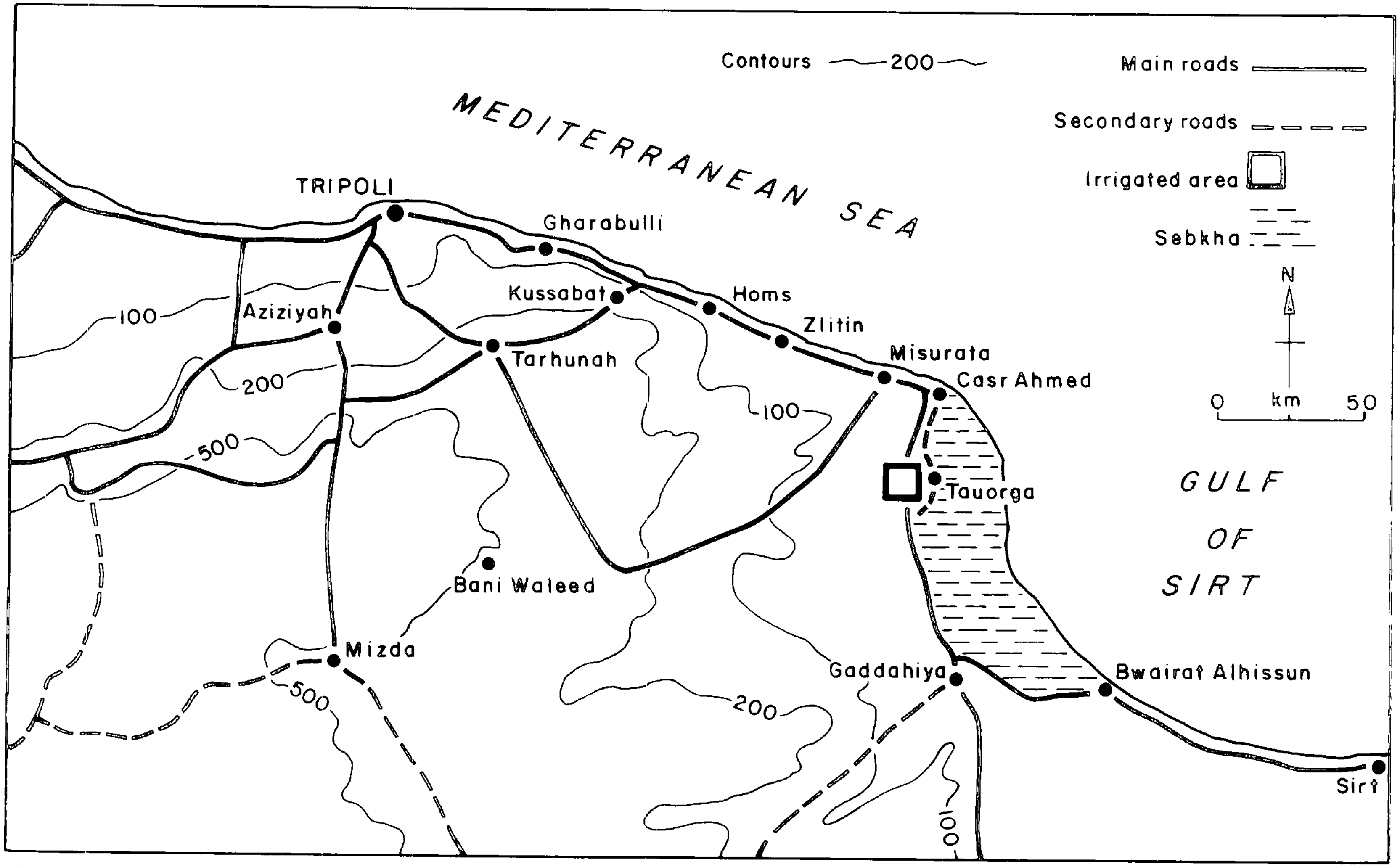
The project area, layout and subdivisions are shown in Fig. No.2.12. The project is subdivided into Areas, Hoshas, Katas and Djosas.

The Areas, their size and the Hoshas they cover are:-

Area West	-	486 ha.,	Hoshas	1 - 7
Area West west	-	443 ha.	"	8 - 14
Area Wadis	-	222 ha.	"	15 - 17
Area East	-	605 ha.	"	18 - 25
Area North of East	-	114 ha.	"	26 - 28
Area South	-	414 ha.	"	29 - 32

In these areas there are 32 Hoshas which are as follows:-

Fig 2.1.1 THE TAUORGA AGRARIAN REFORM PROJECT - LOCATION



Source:- Wakuti, Study on the Tauorga Irrigation Project (Siegen 1965)

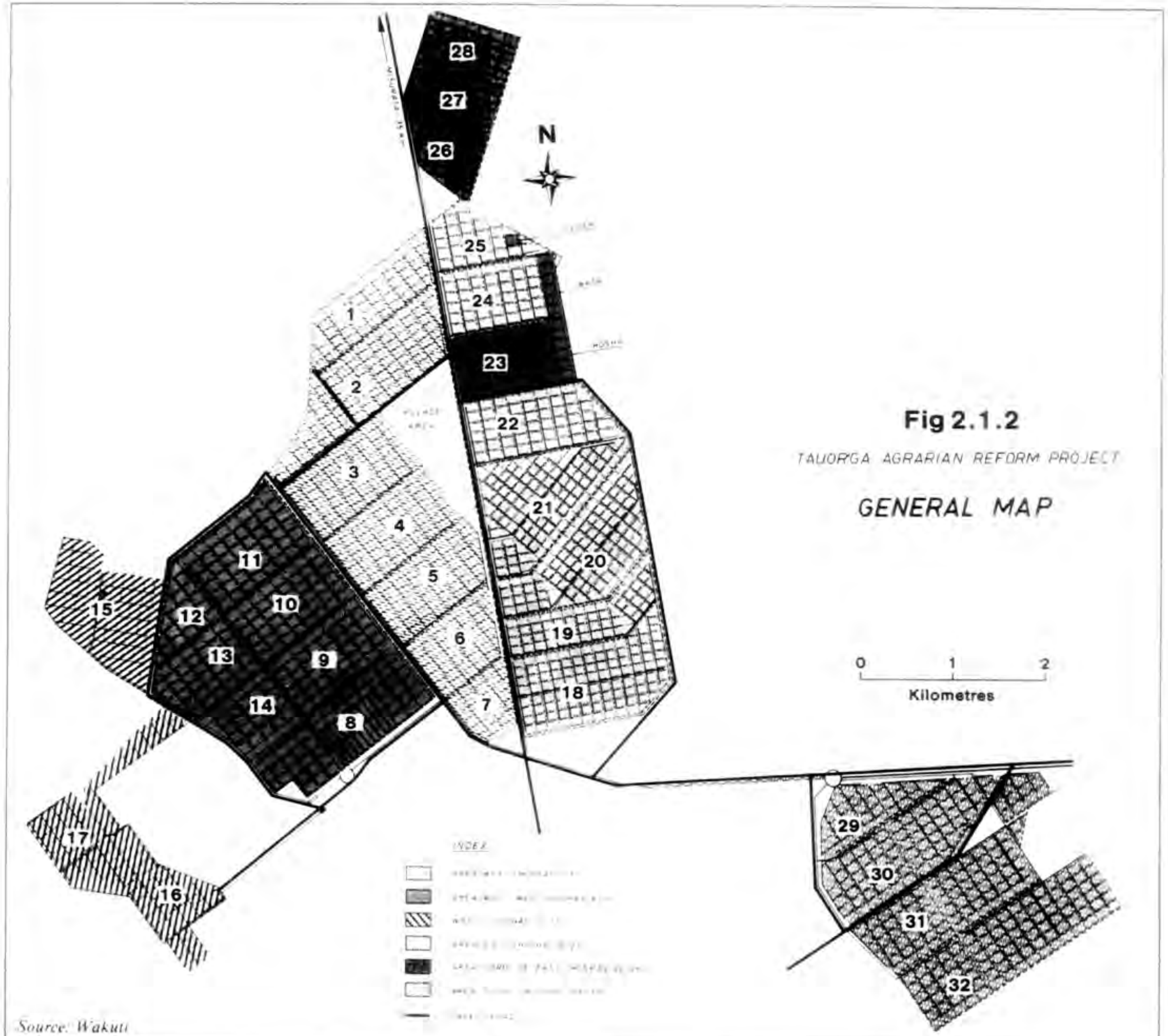


Fig 2.1.2

TAUORGA AGRARIAN REFORM PROJECT

GENERAL MAP

Source: Wakuti

Hosha No.	Size in ha.	Hosha No.	Size in ha.
1	63.2	17	61.8
2	105.5	18	105.5
3	77.9	19	53.0
4	75.6	20	98.0
5	75.3	21	97.3
6	54.4	22	79.5
7	30.1	23	66.8
8	95.3	24	67.1
9	66.5	25	39.2
10	69.5	26	34.7
11	78.1	27	40.8
12	31.6	28	38.9
13	58.1	29	45.1
14	44.4	30	117.3
15	101.9	31	109.5
16	58.8	32	142.7

The Hoshas are subdivided into Katas and Djosas. In the entire project there are 389 Katas and 1,825 Djosas with an average size of the latter of 1.25 ha.

2.2. Outline History of the Project

The springs of Tauorga have been known for centuries but much of their water ran uncontrolled to Sebkha except for a small part, which is used by Tauorga oasis.

The remarkable potential of these great springs, perhaps the largest in Libya (2) (see pp 62-65), has indeed attracted the interest of both administrators and agriculturalists. However, it was not until 1917 that it was decided to make organized use of the water.

That interest culminated in the inception of the Italian project of 1938 designed to irrigate a considerable area of the order of 2,000 ha. Fig.2.2.1., situated west of the Misurata-Sirt main road. (3) Two main factors operated against the implementation of this project: (4)

1. The discovery and exploitation of artesian aquifers at Tammina and El Kararim, in areas which were considered to have superior development potentials.

2. The intervention of the Second World War.

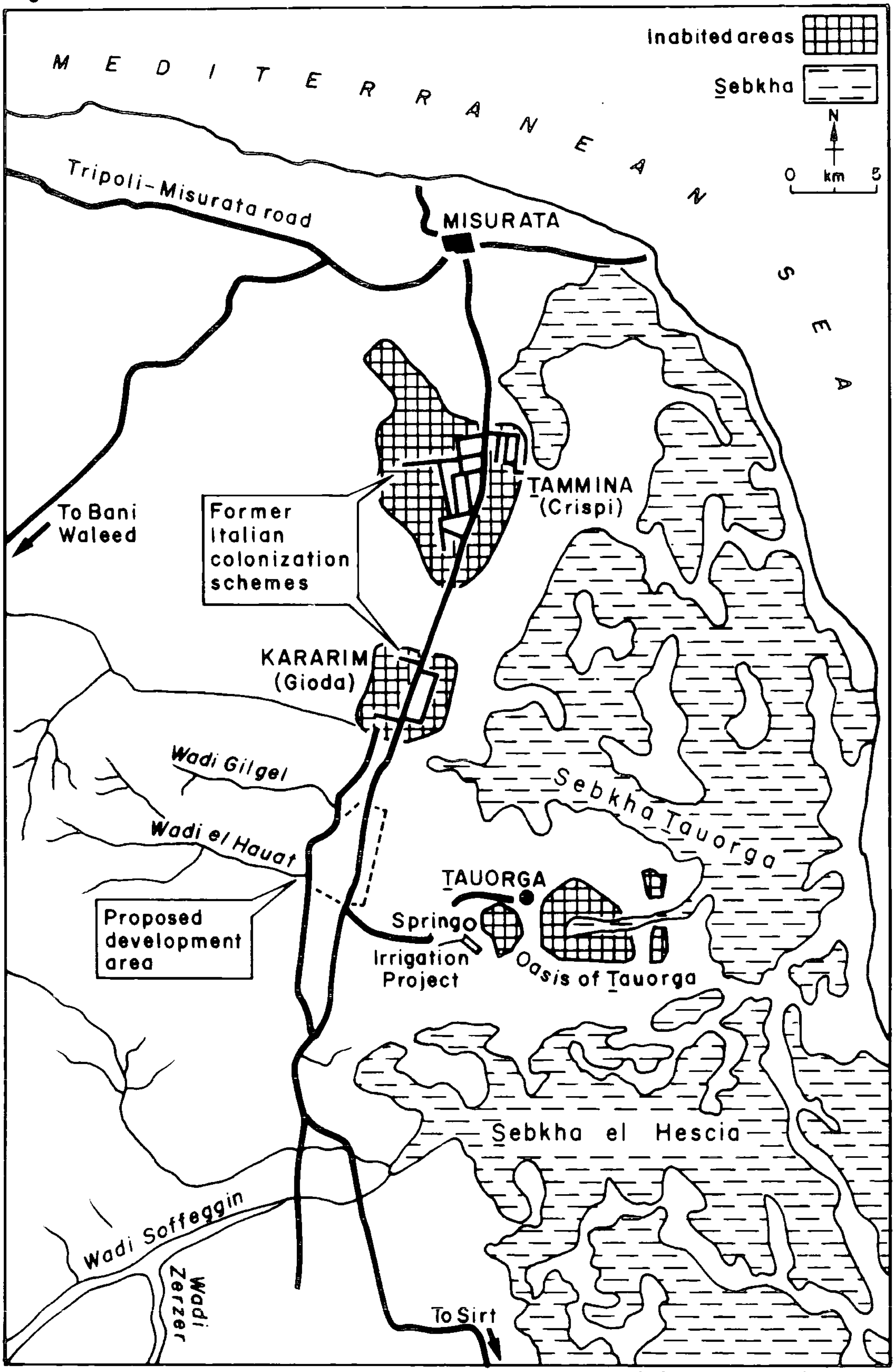
Today these original irrigation works at Tauorga lie derelict and the area is given over to the grazing of livestock and the shifting cultivation of cereals.

In 1957 an experimental farm of 40 ha. was established by the Ministry of Agriculture. Field trials were carried out there from 1962 until 1967 so as to assess the feasibility of salt tolerant crops by a team of specialists from Taiwan. (5)

On August 25, 1960 a team from the Department of Geography, Durham University, Durham, U.K. arrived in Libya and, through the Libyan-American Joint Program, carried out an investigation in the Tauorga area. (6) A reconnaissance survey was made of the soil and water to determine the area suitable for agriculture development and resulted in the publication of two reports in 1960 and 1961, Fig. 2.2.2.

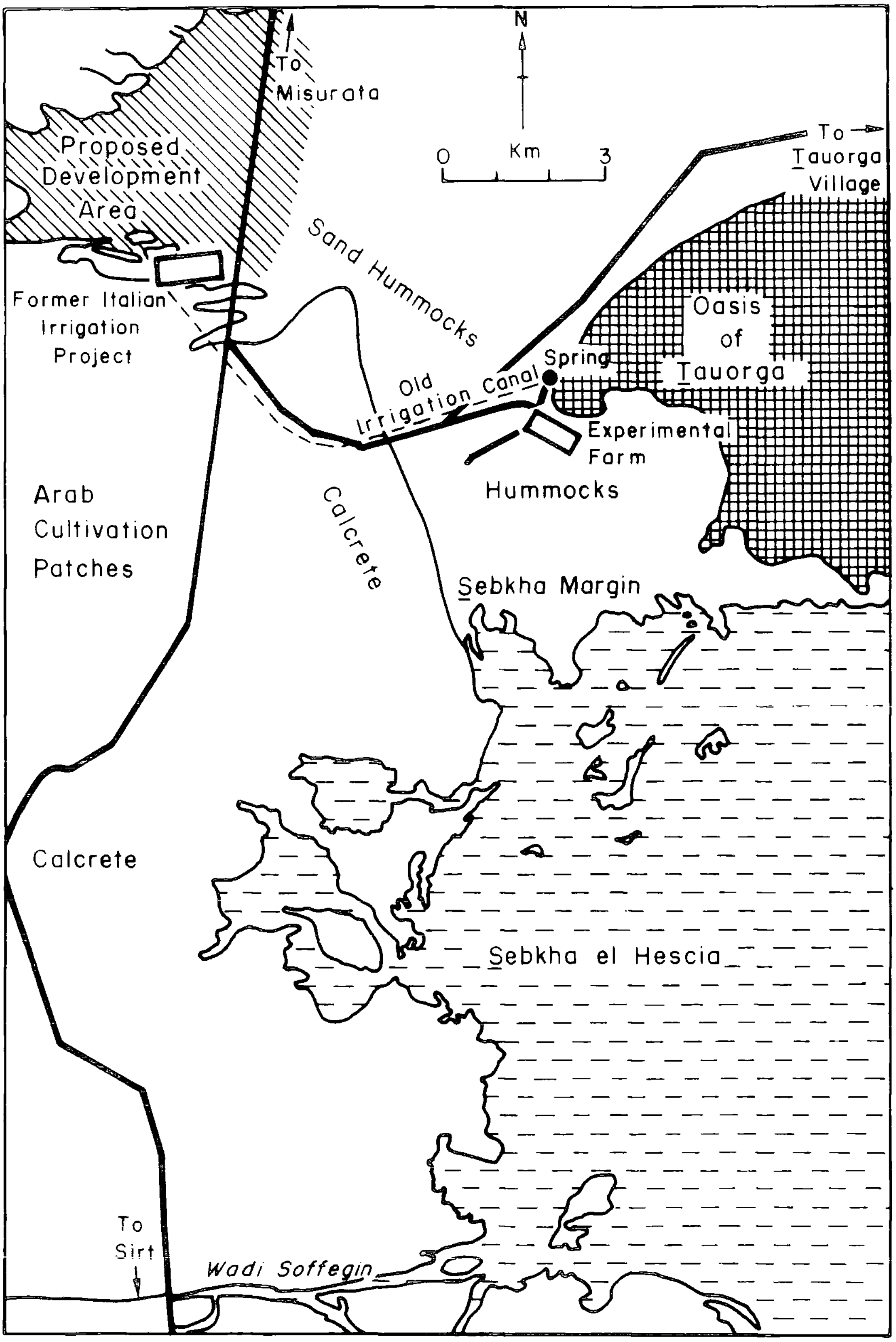
In spring 1965 the Ministry of Agriculture asked WAKUTI KG - 59 Siegen, West Germany to undertake further study to determine the parts of the project suitable for agriculture. Following these, a report was submitted together with designs of their proposed project, at the end of the same year. (7)

Fig 2.2.1 TAUORGA AND SURROUNDING AREAS



Source:- After D.W.Gilchrist Shirlaw et al; Soil survey of Tauorga, 1961

Fig 2.2.2 TAUORGA AREA IN 1960



Source :– After D.W. Gilchrist Shirlaw et al, Soil survey of Tauorga, 1961

In Spring 1970 the Libyan Government asked the Egyptian General Authority for Utilisation and Development of Reclaimed land - GAUDRL - to carry out additional studies. Based on these studies the Egyptian Boheira Company re-designed the project. [8] In August of the same year (8.8.1970) Boheira was given the contract by the Ministry of Agriculture and Agrarian Reform to build the project. [9]

The main contractor Messrs. Boheira Co., brought in the Egyptian firm, Messrs. Hassan Allam Co., which was placed with the execution of all parts of the central village, the erection of the pumping stations and the execution of all asphalt roads as subcontractor. [10]

The German firms KSB and Siemens were given contracts for the supply and installation of mechanical and electrical equipment as subcontractors, with regard to pumping stations and reservoirs only. [11]

The total original value of the contract in November 1970 amounted to approximately L.D.7,000,000 [12] divided into:-

a)	General works	L.D.	2.1	millions
b)	Reformation works	L.D.	3.9	"
c)	Central Village	L.D.	1.0	"

The value of the contract increased by the end of 1973 to a total of approximately 8,300,000. [13]

The construction period (see pp209-211) was to be 2 years, starting in November 1970; however, the actual execution period exceeded 3 years. [14]

In March 1972 WAKUTI KG was contracted for the supervision of Boheira's activities. [15] The development programme for

Tauorga project was to be implemented in three phases:-[16]

First phase - Included studies.

Second phase - was divided into 2 stages:-

A. First Stage included civil works; levelling of land, construction of the central village, pumping stations and water supply, settlers' homes, drainage and irrigation systems, etc.

B. Second Stage represents agricultural stage; leaching, reclamatory cultivation and other aspects such as the planting of internal wind breaks.

Third phase - represents production and marketing.

The first phase of the project was completed by including studies of the proposed development area including

i) Analysing Tauorga Spring water
ii) Measuring the rate discharge of the spring
iii) Analysing soil samples in a total area of 8,000 ha. and selecting the best 3,000 ha.
iv) Planning of the project.

By the end of 1973 the second phase - Stage 1, construction was, basically, completed; this included the central village, irrigation system, drainage system, surveying works, earth works and planting of the outer wind-breaks. However, the construction of houses for the projected 300 settlers' families was not completed (see p. 152). By the beginning of 1974 the Second phase - Stage 2 which includes leaching, reclamatory cultivation and other aspects was initiated by the Land Reclamation Authority of the Libyan Government. However, this did not continue for long and in March 1974 these works of the Tauorga Agrarian Reform project were handed over to the General Company For Marketing and Agriculture Production GCMAP. This company is wholly owned by the Libyan Government and established according to Act No.94, 1973 (17) to serve as executive agency for a range of economic matters. The work is supervised by a committee called The Tauorga Project Supervision Committee - TPSC. This committee, inaugurated by the General Administrative For Agrarian Reform* was established on the 5th February 1974. (18)

In March 1975 WAKUTI was asked by the Ministry of Agriculture and Agrarian Reform to return to supervise the activities of the company for a period of two years ending on 15th March, 1977 and open to extension, if necessary. (19)

Thus the overall management of the Second phase - Stage 2 was carried out by the executive responsibility of the GCMAP under the supervision of the TPSC, with WAKUTI acting as consultants. On the other hand all the maintenance works in the project have to be executed by the TPSC and supervised by WAKUTI. As we shall see, Phase 2, Stage 2 - work, land preparation, was also not completed and Phase 3 has not been implemented on the lines of the original plan.

* Branch of the Ministry of Agriculture and Agrarian Reform.

2.3 Population of the area

The population of the Tauorga region according to the preliminary results of the 1973 population census was 8,698 and the number of agricultural holders was 1,156 - see Table 2.3.1. About 20% of the population is Arabs and Mulattos, 80% negroes called Shushan.[20] The average family size in Libya is 5.8[21] but in the rural areas such as Tauorga region it is more likely to be 8.

Table No. 2.3.1 Population of the Tauorga Region

	Number of House-holds	Number of Persons			Number of Agricul-tural holders
		Males	Females	Total	
Wadi Magas	426	2,142	1,452	3,594	373
Wadi Azrak	335	960	1,058	2,018	302
Wadi Chayzwan	586	1,527	1,559	3,086	481
Total	1,347	4,629	4,069	8,698	1,156

Source: Libyan Ministry of Planning, Population Census (Preliminary results) Tripoli, 1973, p.35.

The dominance of agriculture, at least of landholding, in economic activity is also shown in the above table.

Unfortunately, data about the Tauorga region, in isolation, are not available, but will be extrapolated from the Misurata province (Mohafada) data as it does cover the Tauorga region because the latter is (Mudiria) of this province.

Table No.2.3.2 records the changes which have taken place between 1954 and 1973. Thus the population censuses of the province from the 1954, 1964 and 1973 figures gave totals of 108,000, 130,000 and 178,000 respectively, which gives a corresponding density of 73, 88 and 120 persons per 100 km^2 respectively. The rate of population increase in Misurata province was 20.4% during the 10 year period 1954-1964, and 36.9% during the 9 year period 1964-1973. The sex ration (males per 100 females) is 109.05 and 108.69 according to the 1964 and 1973 census respectively.

All the future farmers of Tauorga region are Moslems; thus a male might be married to up to 4 wives. Table No.2.3.3 indicates the number of males married to one, two, three and four wives in Misurata province (Mohafada) and the rest of Mohafadat in Libya. The relevance of this here is the large number of sons and daughters whom a male will leave after his death and so raising problems of inheritance, and of land division. Out of 60,807 married persons in 1973 there were 6,290 divorced, consisting of 676 males and 5,614 females as shown in Table No. 2.3.4.

What concerns the present thesis is the greater likelihood of males rather than females remarried after divorce since under Islamic Law a divorced female will not inherit from her husband, but his sons and daughters by this divorced female will inherit from him.

The relationship in the Tauorga region between population size, potential labour force and numerical demand

Table No.2.3.2. Area, Total Population and Population Density in Libya, by Mohafada, According to 1954, 1964 and 1973* Censuses

Mohafada	Area		Population						Population Density (No.of per 100 sq. km)		
	% of all Libya Total	Thousands of sq.km.	Thousands Persons			Percent of all Libya Total					
			1954 Census	1964 Census	1973 Census	1954 Census	1964 Census	1973 Census	1954 Census	1964 Census	1973 Census
Derna	6	103	56	84	123	5	5	5	54	82	119
Gebel Akhdar	1	17	67	91	132	6	6	6	394	535	776
Benghazi	1	17	134	225	337	12	14	15	788	1324	1982
El Kalig	41	720	52	80	107	5	5	4	7	11	15
Misurata	9	148	108	130	178	10	8	8	73	88	120
Homs	1	25	124	137	162	11	9	7	496	548	648
Tripoli	-	3	264	406	735	24	26	32	8800	13533	24500
Zawia	-	7	120	164	248	11	11	11	1714	2345	3543
Gharian	9	150	114	181	156	11	12	7	76	121	104
Sebha	32	559	50	67	113	5	4	5	9	12	20
TOTAL	100	1749	1089	1565	2291	100	100	100	62	89	131

* Preliminary Results of 1973 Census of Population (Revised)

Source: Libyan Ministry of Planning, Population Census (Preliminary results) (Tripoli, 1973), p.12

Table No. 2.3.3 Distribution of Libyan married males according to the number of wives in each Mohafada, 1973.

Mohafada	Number of wives in coverture				
	1	2	3	4	Total of married males
Derna	16,657	874	51	2	17,584
Gebel Akdhar	18,617	770	39	-	19,426
Ben-ghazi	44,618	1,781	90	19	46,508
El Kalig	16,617	713	41	6	17,377
Misur-ata	29,346	655	13	2	30,016
Homs	28,396	786	21	2	29,205
Trip-oli	103,228	2,474	110	21	105,833
Zawia	38,444	1,166	34	4	39,648
Ghar-ian	25,226	653	15	2	25,896
Sebha	15,437	1,216	78	8	16,739
Total No	336,586	11,088	492	66	348,232
Total %	96.7	3.2	0.1	-	100

Source: Libyan Secretariat of Planning - General Population Census - Summarized data 1973, (Tripoli, n.d.), p.28.

Table 2.3.4

Population 15 Years & Over, By Marital Status & Sex in Each Mohafada, 1973*

Mohafada	Never Married			Married			Divorced			Widowed			Grand Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Derna	9018	4298	13316	17584	16477	34061	754	1828	2582	364	2921	3285	27720	25524	53244
Gebel Akhdar	8402	3514	11916	19322	18985	38307	429	3233	3662	897	2120	3017	29050	27852	55902
Benghazi	22731	9604	32335	47480	42063	89543	818	7803	8621	1365	3225	4590	72394	62695	135089
El Kalig	6994	2093	9087	17594	17379	34973	362	2990	3352	654	1456	2110	25604	23918	49522
Misurata	12030	4350	16380	29971	30836	60807	676	5614	6290	369	923	1292	43046	41723	84769
Homs	10312	3059	13371	29267	30379	59646	835	4925	5760	472	759	1231	40886	39122	80008
Tripoli	50809	20898	71707	109637	105876	215513	2186	15717	17903	1713	3720	5433	164345	146211	310556
Zawia	17342	6757	24099	40041	40827	80868	933	5927	6860	660	1288	1948	58976	54799	113775
Gharian	11650	4362	16012	26161	27681	53842	957	4348	5305	592	1118	1710	39360	37509	76869
Sebha	7326	2205	9531	16971	18006	34977	209	2956	3165	371	1742	2113	24877	24909	49786
Total	156614	61140	217754	354028	348509	702537	8159	55341	63500	7457	19272	26729	526256	484262	1010520

Source: Libyan - Ministry of Planning,
Population Census (preliminary results) (Tripoli, 1973), p.33.

for land or for jobs in the project was never studied in detail and the numerical changes which have occurred, including those by migration, are not known. The general background of low incomes and under-employment in the region was assumed to justify a belief that settlers and labourers could be found for the project. This is examined further in Chapter Four.

2.4. Land Use

Prior to the development project, the utilization of the area was dominantly pastoral, supporting at a low capacity level the camels and sheep of the passing bedouins,[22] and the inhabitants of the nearby oasis which lay a few kilometres east of the area.

In the project area small-scale extensive shifting cultivation was practised in Wadi Gilgel and Wadi el Hauat Fig. 2.2.1 Also the area supplies the inhabitants with firewood. [23] North and west of Tauorga, hummocks are found over extensive areas which vary in height from a few centimetres to more than 2 metres. [24] The hummocks are composed of blown sand, sometimes with a weak structure and capped by bush vegetation, and often separated by a surface of hardened sand. They are often used as quarries for indurated building material.[25] Most of the buildings in the oasis are constructed in part from these massive salt formations.

The inhabitants in the oasis utilize only a small fraction (see p. 64) of the water available, with the greater proportion meandering through the malarial and snake infested swamps, and the reed-choked channels of the oasis to be lost in the salt marshes or sebkha of the coast where reeds Portulaca oleracea grow which are worked into rush-mats by the inhabitants. Between about 95,000 and 100,000 [26] palm trees are growing in the oasis, and it is these which form the main resources supplying the different items in the family income, as is shown in the following table:-

Table No. 2.4.1. Source of Income, Tauorga

Source	Proportion in percentage
Palm cultivation	40
Reed work	25
Crop cultivation	15
Animal husbandry	5
Administration (policemen & clerical workers)	10
Commercials and drivers	5
TOTAL	100

Source: After Ahmad,N.A., Agrarentwicklung in Tripolitanien, (Heidelberg, 1969), and Marassi, Aspetti Economici - Agrari DELL'OASI DI TAUORGA, L'Agricoltura Colonial,Firenze,1939

Furthermore, there are secondary products made from the palm tree leaves, e.g. boxes for holding dates, brooms, fans, windbreaks and fences.[27] In addition to palms, alfalfa, barley, tomato, melons and water melons are also grown in the oasis.[28]

The former Italian development area is given over to the grazing of livestock and the shifting cultivation of cereals;[29] the original 8 m. deep hand-dug well is now dry and a drilled well, 665 m. deep, supplies water for human consumption.

Approximately 1 km. south of the planned irrigation area there is a small oasis irrigated by a 16 m. deep dug well. Two wells, Al Quidaria, 11 m. deep and Jimi, 8 m. deep, at the northern border of the region supply only animals.

The project under examination here has not involved any major alteration in the use of that land which was traditionally cultivated. Approximately 95% of the project area is a net addition to the total area used for cultivation. Therefore, in the project area, land use was planned entirely to suit commercially oriented farming and the dictates of a newly designed irrigation layout.

2.5. Land tenure

There are several types of agricultural land tenure in Libya but in this thesis we are only concerned with two types:

1. Government lands - operating under governmental company management:-
   - a) Commercial lands for commercial crops and animal products.
   - b) Lands under conservation and erosion control.
2. Inhabitants' lands -
   - a) Traditionally owned by individuals or groups.
   - b) lands expropriated from the Italians and re-allocated to Libyan individuals or groups.

c) Land newly reclaimed by the government and then distributed to inhabitants.

Concerning the land in Tauorga region it is owned by Arabs and Mulattos. In general, in the past the negroes did not own any land but cultivated the fields on behalf of the owners. (30) Some of them, however, had also come to own land of their own. The farm size in Tauorga region is very small, varying between 1 ha. and 4 ha. (31) The smallness of the farm is partly due to the fact that all the oasis inhabitants are Moslems and after the owner dies his wealth is divided between all his heirs according to a standard procedure. Farms are sub-divided again and again, with each succeeding generation and, consequently, the size of each holding becomes progressively smaller until the holding is no longer a viable agricultural unit as shown in Fig. No.2.5.1. This figure is based on an average family size of 8 individuals with the father holding 1,000 ha.

Stage 1. Family - father, wife, 4 sons and 2 daughters.

Stage 2. On father's death, farm divided as follows:-(32)

a) $\frac{1}{8}$th of total goes to his wife.

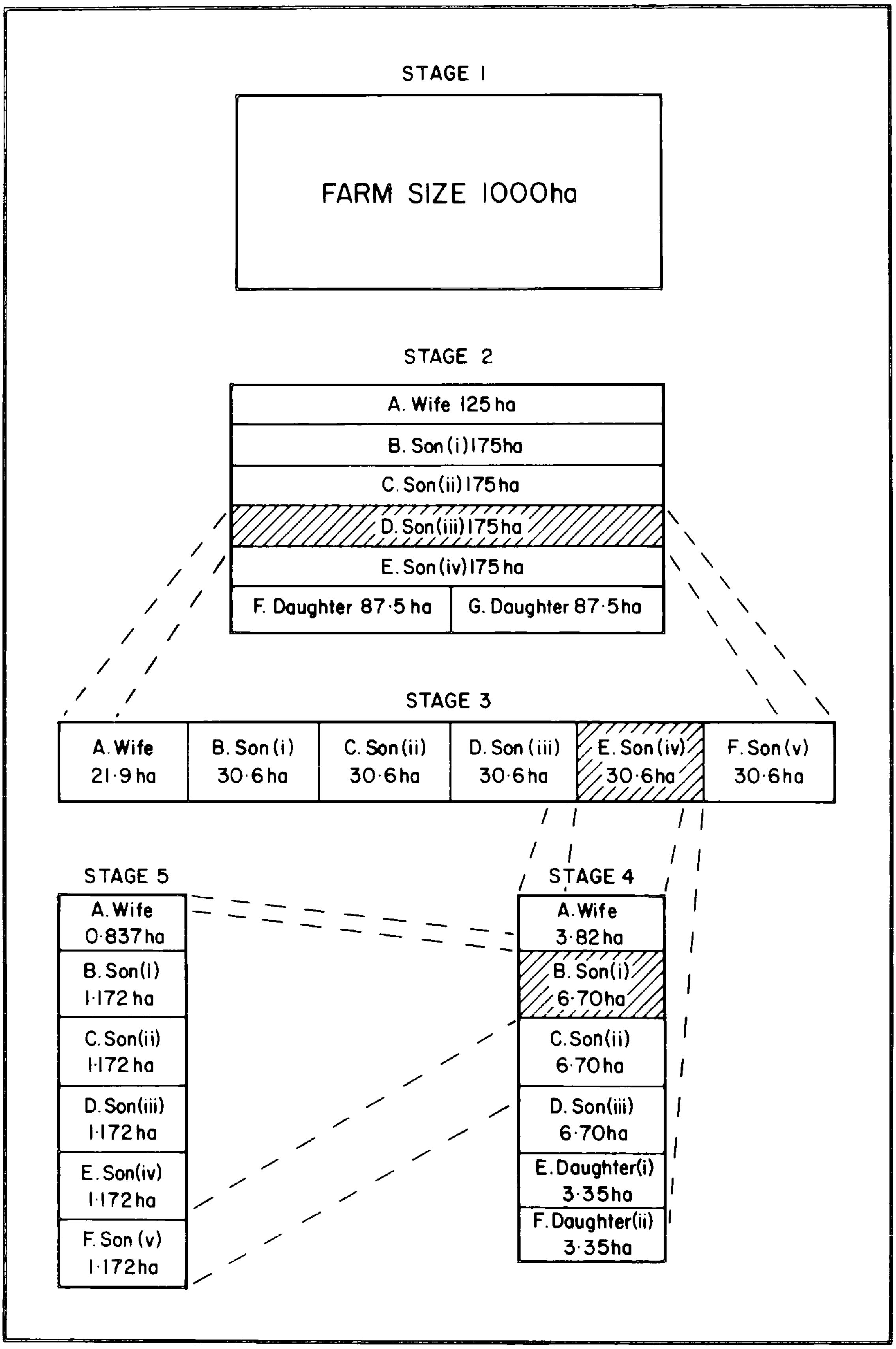
b) remainder divided between the children, but with the daughters receiving half that of the sons.

Stage 3. Farmer owning dies. Divided as per (2) except that in the absence of daughters, the sons receive equal proportions of the remainder after the wife has inherited $\frac{1}{8}$th of the total.

Stage 4. As per Stage 2.

Stage 5. As per Stage 3.

Fig 2.5.1 LAND DIVISION THROUGH INHERITANCE, LIBYA



Source:- Nasr, B.A., Land tenure in Libya, in The Journal of the Geography Department, University of Durham, 1979

Concerning the project area the situation is as follows : 5% of the project area was traditionally owned - land tenure type 2.a - and 95% of the project area is new land under reclamation to be distributed to inhabitants and thus may be classified as land tenure type 2.c.

Government policy for the project laid down that 300 families be settled, regardless of whether they were landowners already or not, as long as they were residents of the Tauorga region. In allocating* the new land consideration was to be given to those who, in the opinion of the relevant government committee, were not in receipt of adequate income. The Ministry of Agriculture and Agrarian Reform awards the farms expropriated from Italian colonists and also newly reclaimed to settlers according to a contract drawn up in accordance with Law No. 123, 1970, [33] which has the following provisions:-

1. The farmer has to cultivate and exploit the farm himself with his family and to keep it fertile and maintain installations.

2. A farmer must take steps to educate himself and provide a certificate of literacy.

3. He must have undergone training in the militia <u>muqāwamah</u> <u>shabīyah</u> .

4. He must pay off all instalments for the land and for installations in the due time.

5. No certificate of ownership to be issued unless all instalments are paid in their entirety - neither the settler, nor his heirs have the right of disposal before paying off

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* selection criteria noted on pp.149 & 150.

all instalments and 15 years elapse.

6. He must obey and follow instructions from the Ministry of Agriculture and the agriculture co-operative society.

7. This contract is liable to cancellation if the settler breaks any of the above provisions.

Conclusion

Given the intended pattern of land-use, holding fragmentation could become a problem. Figure 2.5.1 shows that after 4 successive landholder deaths a farm originally of 1,000 ha. could become 1,512 individual farms of less than 1 ha; this problem being more intense if the farmer is married to more than one female (see Table No.2.3.3) or married twice (see Table No. 2.3.4) This system has created very small fragmented holdings in many parts of libya, such as the Tauorga region, and in Gharian where 177,194 ha. is divided into 162,839 farms, [34] giving a very small average size of farm 1.3 ha. These small farm sizes hinder the use of modern agricultural techniques such as mechanisation, crop rotation, water management schemes and the provision of an efficient infrastructure. The cost of production per unit is higher on such small farms than on larger ones where economies of scale operate and where modern agricultural techniques may be utilized.

With respect to clause 5 of the land allocation regulation, it is clear that after 15 years, and when the payments are completed, the land may again be sub-divided so that these modern farms will share the problems of traditional farms. It is essential that sub-division of holdings is prevented, but the land reform policy included no such recommendations. The problems resulting from the sub-division, of course, are not peculiar to Islamic Law, but have been basic to many traditional forms of land tenure and land inheritance. The question of the degree of independent control of land exerted by settlers and of the degree of absolute ownership after clause 5 above arising in the future (as in other similar projects) will be considered later.

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(31) _Ibid_, p.329.

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CHAPTER THREE

PHYSICAL FACTORS

In this chapter the physical factors involved in the project implementation will be described on the basis of the first study phase of the project involving the investigation of terrain, climate, soil and water by a team from Durham University, and the WAKUTI and the Egyptian GAUDRL in 1960, 1965 and 1970 respectively.

The reconnaissance, investigation and analysis of such physical factors is a primary step which should be carried out before a decision of constructing an agricultural project is taken. Further, the characteristics of these physical factors, firstly very much influence the size, type and design of the agricultural project, and will dictate the type of crops and method of irrigation and drainage systems etc. Secondly, they will determine the quality and quantity of other necessary factors of production (Chapter 4). Thirdly, as they are evaluated against the other production factors, and both together are matched against the project objectives, then it should be possible to decide whether the construction of the project is economically viable, or not.

3.1 Climate

The characteristic features of the climate are its dryness and the high temperature variations between day and night. The absence of protection by higher mountains exposes the land to atmospheric influences from the Mediterranean Sea and also from the desert. (1) As well as being seasonal, precipitation occurs only in short, sudden bursts, and evaporation is greater than precipitation.

In winter the temperature falls to freezing point whilst in summer, maximum temperatures of 40°-42°C are not infrequent.[2] A highly peculiar and unpleasant climatic phenomenon is <u>Ghibli</u>, a hot dry desert wind from south-east to south-west carrying fine sand, especially during March - September. It can also produce a temperature rise of between 15°C to 25°C within a few hours.[3] During the Ghibli the relative atmospheric humidity not infrequently sinks down to 5%.[4] Climatic data for the project area were not available for the survey phase since it was only in 1976 that a meteorological station was erected at the project. This is not an uncommon situation in L.D.C.s in general and -

> "In no area of Libya do we have all the information that should be collected" (J.R. Jones) (5)

Therefore,data from Misurata, the closest station where data is available, have to be used. Table No. 3.1.1 shows a summary of the meteorological data from Misurata Station.[6] Figure No. 3.1.1 shows the Temperature Mean Max., T. Mean, T. Mean Min., T. Ex.Max., T.Ex. Min. Figure No. 3.1.2 shows the mean relative humidity and mean monthly duration of sunshine in hours. Figure No. 3.1.3 shows the mean rainfall.

Whilst the climate is harsh, the general climatic conditions nevertheless allow the growth of many different plants, given reasonable management. However, ecologically, the range of crops which can be considered as climatically suitable is then further restricted by soil conditions and water availability.

Fig. 3·1·1

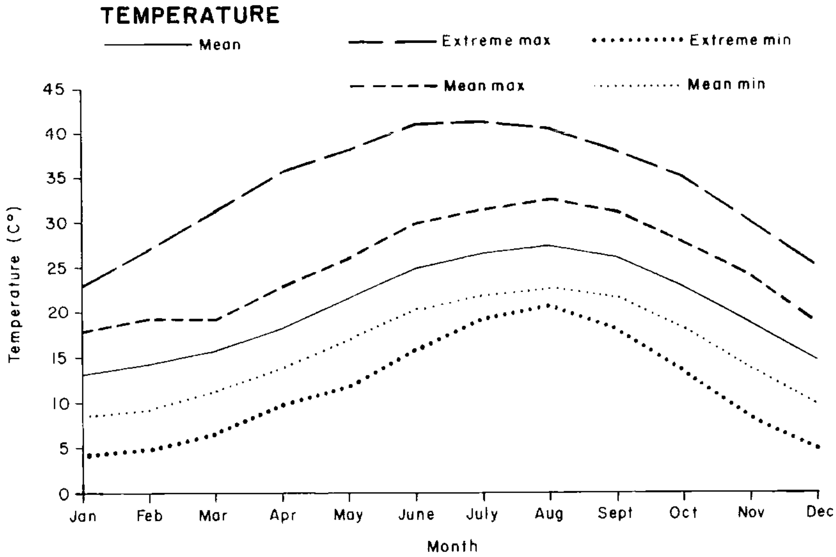

Fig. 3·1·2

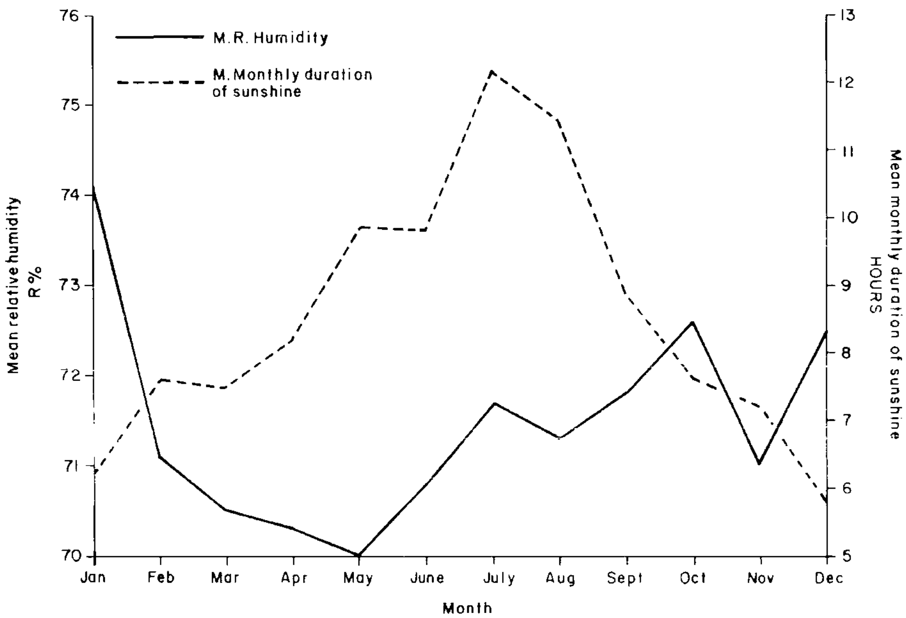

Fig. 3·1·3

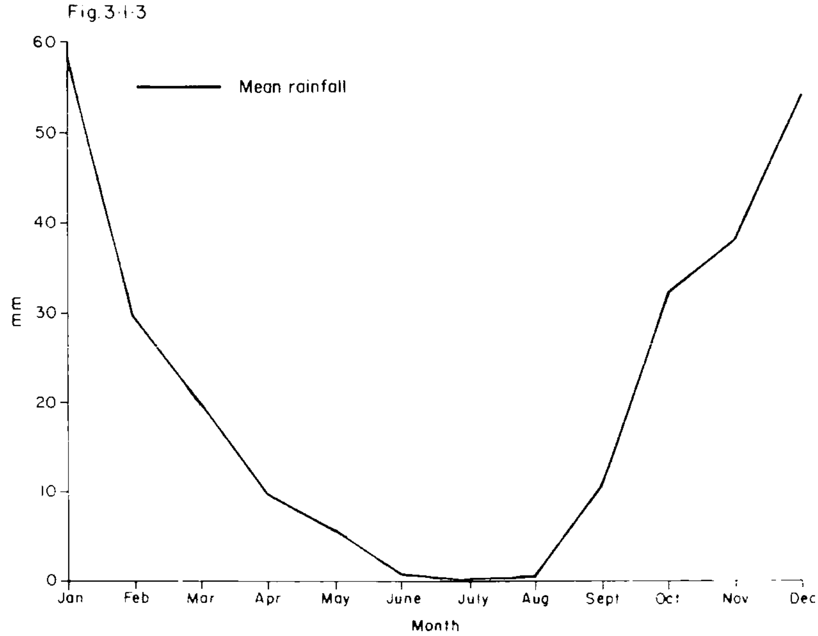

Table No.3.1.1 Summary of the Meteorological data - Misurata

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period Average Years
T.Mean Max	18.0	19.3	19.3	23	26	29.9	31.4	32.5	31.1	27.8	24	18.6	31
T.Mean	13.3	14.3	15.9	18.4	21.6	25	26.6	27.5	26.3	22.9	18.9	14.7	31
T.Mean Min.	8.5	9.3	11.2	13.9	16.9	20.2	21.9	22.6	21.6	18.3	13.7	9.6	31
T.Ex.Max.	23.2	27	31.1	35.4	38	41.2	41.3	40.5	38.0	35.2	30.1	25.1	33
T.Ex.Min.	4.2	4.8	6.5	8.8	11.8	15.9	19.2	20.7	18.1	13.8	8.5	5.0	33
Mean Rel.Hum.	74.1	71.1	70.5	70.3	70	70.8	71.1	71.3	71.8	72.6	71.0	72.5	31
M. Rainfall	59.0	29.5	19.9	9.5	5.7	0.8	0.01	0.5	10.5	31.54	37.87	53.9	33
M.Monthly duration of sunshine in hours	6.14	7.60	7.5	8.19	9.92	9.82	12.17	11.44	8.85	7.67	7.22	5.87	13

3.2 Soils

The Tauorga soils have been formed under semi-arid conditions. The great temperature variations between day and night, together with the short-period heavy rainfall resulted in intensive and deep weathering of the tertiary marls and marly limestone. [7] On this weathered surface aeolian deposits were formed, which in places have been 'fixed' by vegetation. Thus, typically loess layers were formed, the thickness of which have been changed by spatially variable wind action. Besides the erosion and deposition by wind there is also action by water, for example in the lower reaches of the wadis Gilgel and El Hauat where wadi floods have laid down good loamy alluvia.

Precipitation in the project area is low (approx.125 mm/year) and frequently violent. [8] The loess surface is rapidly impacted and the water flows off rapidly, varying according to the topography, causing heavy erosion of the loess. [9] By sheet flow and gully erosion deposition takes place in the lower parts of the terrain, while the heights are almost stripped of loess and shallow soils. [10] Since evaporation is greater than precipitation, consequently capillary action produces an upward movement of soil-water which evaporates on the surface leaving a concentration of dissolved salts and solids on the surface and in the upper soil layer. [11] In general, because of the topographic conditions in the project area, the surface and subsurface water flows away to the East. The natural gradient fall gradually decreases to the East and the water table usually rises associated with not only a higher concentration of salts but also in the formation of relatively shallow swallow holes in the soluble carbonates.

A number of studies were carried out on the project before its execution. In the first, performed by a team from Durham University in 1960, a number of soil profiles were studied and sampled. In 1965 the German Consulting firm WAKUTI carried out further studies on the area including soil survey and soil mapping of the area. In 1970 another soil survey study and mapping of the area was performed by a team from the Egyptian GAUDRL, the report of which was the basis for the choice of land for reclamation. The main soil characteristics in the area, as rated by the survey, were as follows :

Mechanical Analysis

Soil texture (12) varies between light (loamy sand and sandy loam) to medium (silty loam and loam) to relatively heavy (sandy clay and clay loam). Water infiltration rate through soil, according to GAUDRL, varies between 9 cm/h to 37 cm/h. (13) However, the report of Durham University mentioned rates from 0.25 to 7.3 cm/h (14) and the WAKUTI Study 1965 from 1.2 to 14 cm/h. The pore volume is relatively high and makes up about 50% by volume of all soil horizons. The storability of water available for plants was stated to be between 10 and 15% of the volume of soil water on average.

Hard soil layers :(15) Hard layers were reported to exist in the soil; the formation, thickness and nature of the materials varying from place to place with some consisting in the main of calcium carbonate and others of calcium sulphate. They were reported to have no hindering effect on water permeation in the WAKUTI study, whilst the GAUDRL report referred to them as composed of marl or marly material. Durham University study referred to a consolidated soil layer of hardened material forming sandstone and sandstone-like material. The GAUDRL report also suggested a need for subsoil breaking of the material lying near the surface before land levelling should be effected.

Chemical Analysis

The chemical analysis formed the basis of soil classification by GAUDRL.

a) Classification 'a' good land. Table No. 3.2.1 below shows the soil analyses of a typical sample.

Table No. 3.2.1

	Depth cm		
	0-15	15-40	40-65
Electrical conductivity millimhos/cm			
1 : 1 Soil : water	1.45	2.07	1.22
PH in water	7.70	7.80	7.85
K2O (mg/100 of soil)	16.0	12.0	7.0
P2O (mg/100 of soil)	8.0	5.0	5.0
CaCO3 %	12.40	3.38	2.97
CaSO4 %	1.44	4.92	4.72
C %	0.19	0.21	0.41
C/N %	12.3	9.6	8.7
Na (meg/100 of air dry soil)	0.69	1.58	0.46
Ca " "	0.47	0.39	0.50
K " "	0.04	0.02	0.02
Mg " "	0.29	0.55	0.52
SO4 " "	0.76	0.78	0.52
Cl " "	0.86	1.73	0.76

Source:- WAKUTI, Tauorga Agrarian Reform project (Germany and Switzerland 1970) p.7.

b) Classification 'b' arable land. Table No. 3.2.2 below shows the soil analyses of a typical sample.

Table No. 3.2.2

	Depth cm			
	0-3	3-10	10-50	50-65
Electrical conductivity millimhos/cm				
1 : 1 Soil : water	13.64	6.93	8.55	3.54
PH in water	8.10	8.05	8.10	7.75
K2O (mg/100g soil)	19.0	16.0	10.0	6.0
P2O2 "	6.0	4.0	4.0	3.0
NaCO3 %	8.23	1.04	0.21	1.10
CaSO4 %	4.47	5.65	13.41	5.76
C %	0.46	0.12	0.32	0.15
C/N %	14.2	9.6	10.5	8.3
Na(meg/100 air dry soil)	1.97	1.38	7.15	2.12
Ca " "	0.73	0.63	0.72	0.75
K " "	0.15	0.83	0.39	0.13
Mg " "	1.16	1.38	3.50	0.70
SO4 " "	1.23	1.75	4.76	0.95
Cl " "	2.84	2.54	7.58	2.87

Source:- WAKUTI, Tauorga Agrarian Reform project (Germany and Switzerland 1970) p.8.

Soils of the project area were classified according to GAUDRL as follows, together with an estimate of the area of land in each class.[16]

1. A1 = 511 ha. : cultivable, more than 100 cm. deep, light to medium in texture, salinity 4 mmhos/cm or more, needs little levelling.

2. A2 = 1797 ha. : cultivable, profile at least 50 cm. deep overlying a loose-marl layer down to 150 cm, light texture, salinity medium to high, needs some levelling and leaching.

3. A3 = 2095 ha. : cultivable, less than 50 cm. deep, light texture, overlying a transformed marl layer with concretions of calcium carbonate down to 60 cm; similar to class A1 except for shallowness of the soil and sandier condition, needs levelling and leaching.

4. B = 1901 ha. : less than 50 cm. depth, light overlying a soft marl layer, high to extremely high salinity, needs slight levelling since soil is shallow and needs leaching.

5. R = 1782 ha. : shallow, rock near surface at 10-40 cm. not suitable for cultivation.

These soils are tabulated in Table No. 3.2.3 and indicated as mapping units in Fig. No.3.2.1.

On the basis of soil and land classification the Project area of a possible 8,000 ha. was selected. According to the GAUDRL report, (17) there were 5 areas chosen for agricultural development and reclamation, as follows:-

Area 1:- About 200 ha; includes Wadi Meriam with few salinity problems.

Table 3.2.3 Classification of soils of the Project area

Class	General character	Degree of Salinity	Land Capability
A1	Thick loess layer 100 cm deep	Low	Arable
A2	Thick loess layer 50 cm deep	medium to high	
A3	Thin loess layer 25 to 50 cm.	Low	
B		high - extremely high	
R	Shallow or rock		Non Arable

Area 2:- West of Misurat-Sirt main road. The area immediately by the road (about 600 ha.) having land varying between A2 and B classes; with medium to high and high to extremely high; slight salinity. The adjacent area to it (about 700 ha.) is of A3 and A2 classes; salinity is either low or medium to high.

Area 3:- East of Misurata-Sirt main road with an area of about 900 ha. most of a B class.

Area 4*:- Soil of this area (about 600 ha.) is high to extremely high saline with most of it A3.

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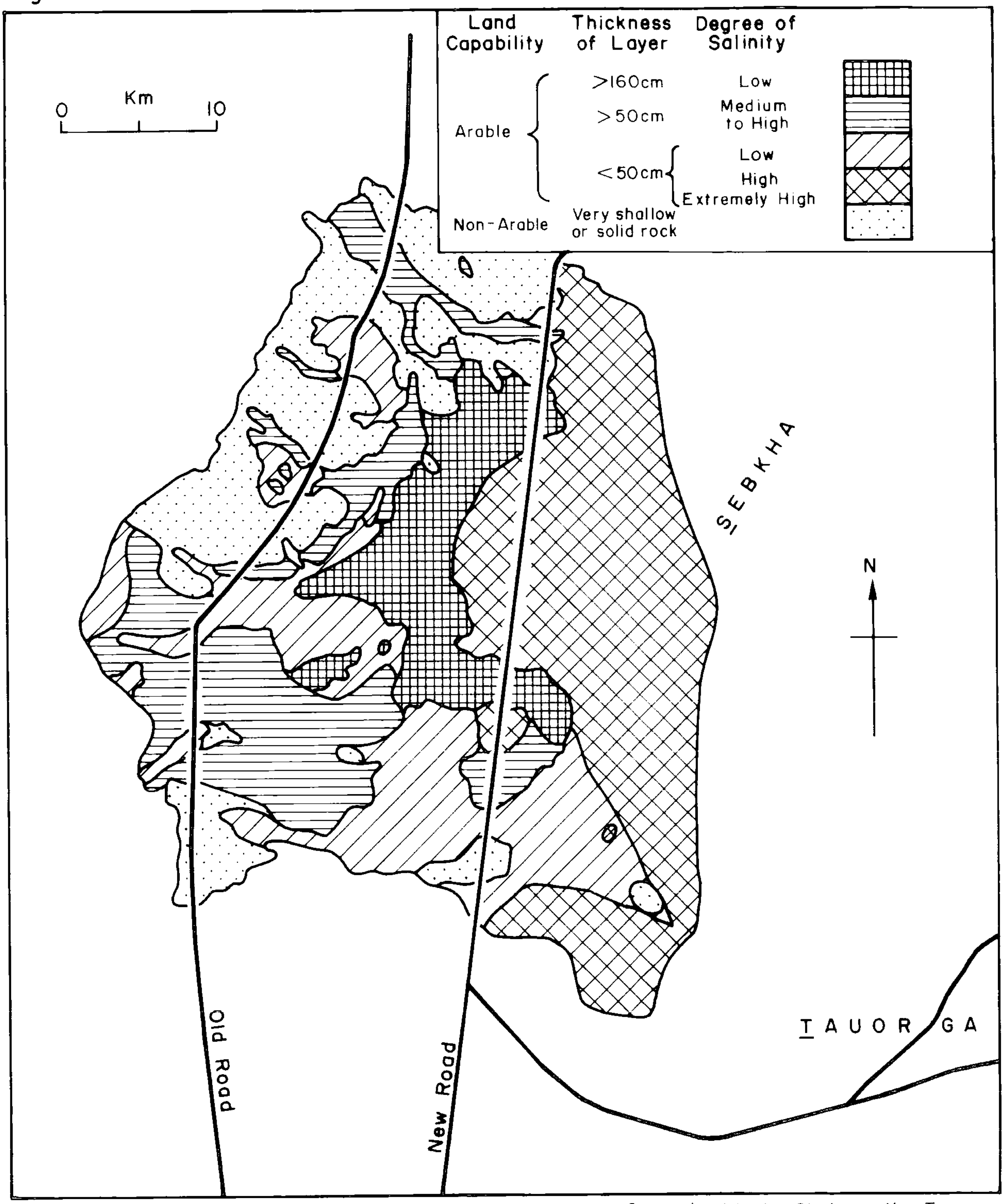
* Unfortunately no map of land classification is available for this separated area, which now is called Area South.

Fig. 3·2·1 Land Classification



Source: Wakuti, Study on the Tauorga Irrigation project (Siegen 1965)

The determination of the figure of 3,000 ha. for actual development [18] was based on the quantity of the springs' discharge which was recorded as approximately 3.02 cu.m./sec. i.e. it could supply the water requirements of both irrigation and leaching of a selected 3,000 ha. (after deducting the quantities for the experimental farm and use by the people in the oasis (see p. 64).

3.3 Topography

The project area lies between contour 6.00m from the East and 23.00m from the West. The area in general slopes from West to East with an inclination of approximately 0.2%,[19] from about 23 m a.s.l in the West to 6 m a.s.l in the East. At the western border of the sebkha of Tauorga the height is approximately 10 m. above sea level, there follows a slope to an area 15 m. above sea level, with hummocks of alluvial blown sand. These hummocks are rarely found in the area south of the village Kararim.

In order to prepare the land for agriculture production, and since a flood irrigation method was to be used, land levelling is necessary. In mapping unit A1 and A2 (see Fig. No.3.2.1) levelling does not create any serious problem because the loess layer is more than 50 cm. thick. Areas A3 and B required levelling, but because of the thinner loess layer overlying extremely compacted lower marl horizons, a deep ploughing is also required in order to mix the loess and marl. Where the layer is extremely thin, i.e. under 25 cm. levelling should be avoided. [20] Recommendations to this effect were made before the construction phase. However, levelling was carried out on all fields during the construction phase of the project to give slopes of 0.1 - 0.3% rectangular to the lateral irrigation canals and 0.05% in the direction of the lateral irrigation canals. (21)

3.4 Water

The resources of water available to the project area include:-

A - Precipitation

B - Groundwater

- Dug wells
- Deep drilled wells
- The Tauorga springs

Quantitative estimates of discharge and of project irrigation requirements

Water quality

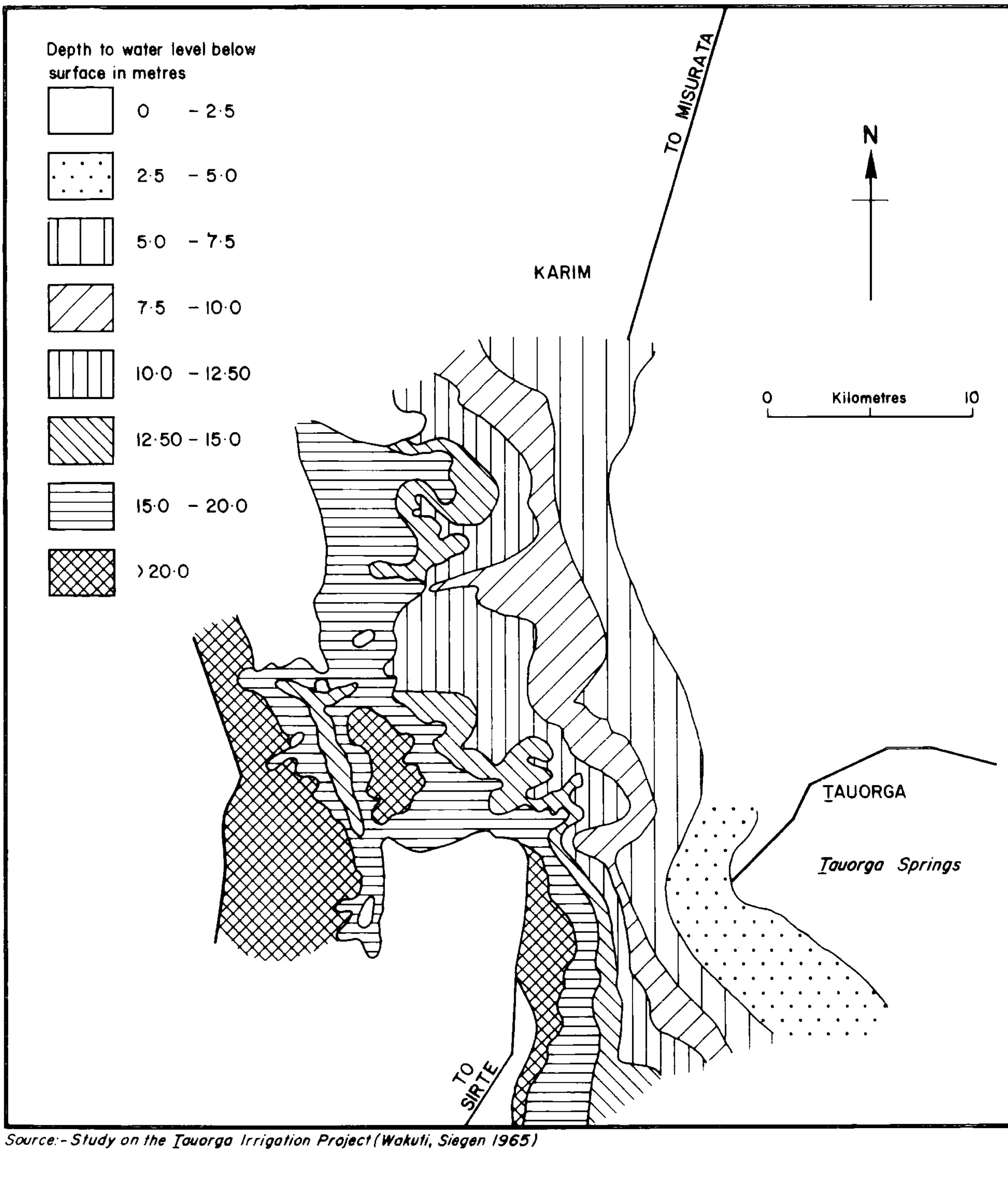
A - Precipitation: In order to be of greatest benefit it should have the following characteristics -

The amounts should be sufficient to replace moisture depleted by evaporation and transpiration from the root zone. Frequency of precipiation should be enough to replenish the soil moisture before plants suffer from lack of moisture. The intensity should be low enough so that water can be absorbed by the soil.

In Tauorga the case is that the amount, frequency and the intensity of precipitation are all unsuitable for the support of permanent cultivation.

B - Ground water: (Fig. 3.4.1) Ground water contained within the soils and their parent materials (i.e. at shallow depths) can be utilised by plants which are able through their

Fig 3.4.1 HYDROGEOLOGICAL MAP – DEPTH TO STATIC WATER LEVEL



Source:- Study on the Tauorga Irrigation Project (Wakuti, Siegen 1965) root systems to reach the water table. The upward movement of ground water by capillarity from the water table into the root zone can be a major source of water for plant growth

Unfortunately whilst the water table lies between 2.5 m. and 20m. below the surface (Fig. 3.4.1), this ground water is saline and cannot be used for irrigation and is in fact responsible for the high salt content in the soils (See p. 51) this condition being due to bad drainage.

Dug wells (22)

The chemical quality of the water of these wells is shown in Table No. 3.4.1. According to chemical analysis the shallow wells have a high salt content, with chlorides and sulphur exceeding 1000 ppm.

The upper aquifer is fed mainly by the rare rainfall and can only supply a limited amount of water through the shallow wells. South of Tauorga there are wells up to 24 m. deep supplying the water needs of the farms in that locality. The output of these wells is estimated to be 0.5 cu.m/se. Obviously it is not a reliable or adequate resource of water for this project.

Drilled deep wells (23)

A number of drilled wells between 528 and 665 m. deep are found in the area (Table No. 3.4.2) These wells are artesian or semi-artesian, and most of them have to be equipped with pumps. However, some of them deliver artesian water by natural outflow. Most of the water originates from the upper cretaceous limestone stratum, about 500 to 600 m. deep. The deepest well, 665 m. deep, is in the project area 1.250 km.

Table No. 3.4.1 Depth of wells, and the chemical quality of water - Dug wells

No.of Well	Name of Well	Depth of Well in m.	Depth to Water Level in m.	Salinity ppm	CL ppp	Classification (Jones 1964)	Temp-erature $+^{o}C$
19		8.00	dry	-	-	-	-
2	Farm near Mantiquat Al Qurayy'r	16.10	15.50	3,284	1,007	poor	20.5
3	Bi'r Aniyah	13.70-14.50	13.00	2,680	837	poor	18.0
4	Bi'r AlQidariyah	11.10	10.00	3,228	858	poor	-
5	Bi'r Jimi	7.50	6.65	1,720	440	fair	20.0
9	Bi'r Al Judayyidah	18.50	18.00	2,250	979	poor	-
10	Bi'r Qasr Bin Karmah	24.00	dry	-	-	-	-
11	Farm I south-west of Tauorga	13.50	dry(15.00)	-	-	poor	-
12	Farm II south-west of Tauorga	23.80	11.50	-	-	poor	-
13	Shallow well of Farm II south-west of Tauorga	12.00	11.00	-	1,113.4	poor	-
14	Shallow well of Farm III south-west of Tauorga	9.80	9.30	-	1,446.8	brackish	-
15	Bi'r Al Kararim	3.25	3.00	-	1,099.3	poor	-
171	Shotpoint borehole M3/171 (1956)	27.20	18.10	-	-	-	-

Source: WAKUTI, Study on the Tauorga irrigation project (Siegen 1965) pp.24-36.

Table No. 3.4.2. Depth of wells and the chemical quality of water - Drilled deep wells

No. of Well	Name of Well	Depth of Well in m.	Depth to Water Level in m.	Salinity ppm	CL ppm	Classification (Jones 1964)	Temperature $+^{\circ}C$
6	Artesian well - Kararim		+1.9	-	361.7	Fair	30
7	Drilled artesian well (Pozzo No.12)	528.00	+1.75	1,700	355-422.6	Poor	34
8	Artesian drilled well	657.00	+0.5	3,746	1,482.2	Poor	-
17	Drilled deep well (Pozzo No. 15)	607.00	-	4,020-4,670	1,730-1,880	Brackish	39.5
	Drilled deep well Tauorga	665.00	(Blocked)	-	250.00	Fair	39.0

Source: WAKUTI, Study on the Tauorga Irrigation project (Siegen 1965) pp.36-41.

west of the main Sirte-Misurata road. An output of 130 cu.m./h. for this well in 1956 was measured. Other wells in the area supply up to a maximum of 250 cu.m/h. The following Table No. 3.4.3 shows the output of a number of wells. (24)

Table No. 3.4.3

Well	Delivery in m^3/h	Year
pozzo 15	200	1939
pozzo 14	250	1939
pozzo 13	150 - in 1940	1956 only 30 m^3/h
pozzo 12	250	
pozzo 20	70	1939
Misurata 1	200	1938
Tauorga deep well	130	1956

The average output of these wells is 178 cu.m./h. (25) accordingly and considering a projected 2.93 cu./m/sec. for the irrigation project would require 59 wells. Therefore, it was regarded as more economical to use the Tauorga springs than to drill new wells, particularly since the quality of water from these wells is not expected to be better than that from the springs.

The Tauorga Springs

Given the inadequacy of precipitation, the unsuitability of shallow groundwater and the high cost and low volume expectations from drilled wells, the natural springs of Tauorga form the basic water resource for project development. These are considered in detail below.

These two springs are situated at a distance of approximately 5 kms. west of Tauorga town. These are also perhaps the largest natural springs found in Libya, total discharge being shown below:-

1. Before World War II the output of the springs was calculated to be 3.5 cu.m/sec.[26]

2. In November 1961 it was measured as 5.00 cu.m/sec.[27]

3. In April 1965 measurements by WAKUTI indicated 3.020 cu.m/sec.[28]

4. The flow measurements taken by GEFLI in 1971-1972 gave the following results:-[29]

in 22.10.1971	2.47 cu.m/sec.
9.2.1972	1.95 cu.m/sec.
28.3.1973	1.95 cu.m/sec.

5. In 1974 3.4 cu.m/sec. (measured by Boheira Company Limited, Egypt) [30]

6. In Spring 1974, a French consultant company GEFLI carried out flow measurements and recorded a discharge of 2.05 cu.m/sec.[31]

7. In December 1975, a further consultant company, WAKUTI KG carried out measurements and recorded 2.3 cu.m/sec.[32]

8. In 1977 measurements indicated 1.9 cu.m/sec.(measured by Ministry of Dams and Valleys). [33]

These fluctuations appear to have been caused by an increase in water extraction by the wells drilled near the springs in recent years and reduction of pressure but the general question of control of water extraction and competition between wells and springs remains to be discussed later. The figure of flow i.e. 3.020 cu.m/sec. was taken to represent available water, the allocation of water in the planned project being as follows:-

a) 0.1 cu.m/sec. for the experimental farm, see Fig. 3.5.1.

b) 0.1 cu.m/sec. to supply the people of Tauorga oasis.

The remainder, 2.82 cu.m/sec. would supply the project area.

The Tauorga Springs and the artesian water of the deep wells originate in the limestone layers of the upper cretaceous and it is probable that this relatively large quantity of artesian water originates in the eastern part of Jebel Nefousa with its higher annual rainfall about 350 mm. [34]

Jebel Nefousa is an area of hill land in Western Libya. In general the upper cretaceous beds, mainly calcareous, of which Jebel Nefousa is composed dip gently to the south. A number of subaerial erosion surfaces are recognisable on the heights of the Jebel and on the wadi sides, the number of stages apparently two in the western part of the Jebel and as many as five in the Jebel around Jadu. The northern scarp face appears to have been formed by marine action and is one of the high terrace scarp faces characteristic of Tripolitania and Cyrenaica. The upper valley fill material of the Jebel lacks the roundedness of the younger gravels of Eastern Libya, and seems to have been deposited under conditions not very different from those of the present.[35] The absence of impermeable layers in the Cretaceous beds makes it easy for the precipitation water to penetrate and it also tends to flow, in periods of intense rainfall along the dip slope. Consequently the water sinks through the predominant lime stones and deeply penetrates the geological structure.[36] Very little is known of the hydro-geological processes involved but it is generally accepted that it is water from these beds which appears in a zone of structural weakness as artesian springs at Tauorga. The quantity of water represented by a flow of 2.82 cu.m/sec was assumed in the first place to allow, given irrigation management of the type described later, the irrigation of approximately 2283.58 hectares.

Project Irrigation Water Volume Requirements:-

The quantity of irrigation water for the permanent cultivation plan (pp.66-70) was determined by the Blaney-Criddle formula, converted to a metric system

$$\text{ET pot} = P \times \frac{45.7 \times t + 813}{100} \text{ (mm/month)}$$

where:-

P = monthly percentage of the yearly number of daylight hours.

t = sum of the products of the medium monthly temperature in degrees centigrade.

For the conversion of the estimated "potential evapotranspiration" to the "actual evapotranspiration" the formula

$$\text{ET act} = K \times \text{ET pot}$$

where:- K is the crop factor to be applied

The irrigation water consumption of the crops to be cultivated in the project in the permanent plan (p.159) is shown in Table No. 3.4.4 in mm/month. Accordingly, the irrigation water consumption of these crops weighted according

Table No. 3.4.4 Irrigation Water Consumption of Crops in mm/month

Suggested crop for permanent plan	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Fruit	33.04	51.97	69.42	83.19	102.44	117.04	139.65	122.41	97.77	81.76	52.38	32.37
Grains	46.25	60.12	83.21	71.52	52.93	118.87	129.67	133.88	107.72	94.90	57.37	47.55
Fodders	53.80	61.24	82.04	109.4	153.69	192.85	229.43	200.82	147.49	112.42	86.05	63.74
Winter veg.	56.63	40.76	-	-	-	-	-	-	66.29	104.99	166.00	85.99
Summer veg.			50.49	102.17	145.13	179.22	149.62	122.40	-	-	-	-

Source : Boheira Co.Ltd. Technical Report No.1 (Egypt 1970), p.11.

Table No. 3.4.5 Irrigation water consumption of the crops mm/month Proportion cultivated of the project area

Crop	Proportion cultivated of the project area	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Fruits (20% citrus and grapes)and (20% almond and olives	40%	13.22	20.79	27.77	33.27	40.97	46.82	55.86	48.96	39.11	32.70	20.95	12.95
Grains	20%	9.25	12.02	16.66	14.30	10.59	23.76	25.94	26.78	21.54	18.98	11.47	9.51
Fodders	20%	10.76	12.23	16.41	21.89	30.73	38.77	45.88	40.16	29.50	22.49	17.21	12.75
Winter veg.	20%	11.32	8.14	-	-	-	-	-	-	13.26	28.98	21.20	17.20
Summer veg.		-	-	10.10	20.44	29.02	35.84	29.94	24.48	-	-	-	-
Total Crop Formation	100%	44.55	53.18	70.94	89.90	111.31	145.19	157.62	140.38	103.15	103.15	70.83	52.41
Daily Consumption proportion	mm/Day	1.44	1.90	2.29	3.00	3.60	4.84	5.08	4.53	3.45	3.33	2.36	1.70

Source: Boheira Co.Ltd. Technical Report No.1 (Egypt 1970), p.13.

Table No.3.4.6 Water requirements for the crops M^3/ha/month

Crop	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Fruits	203	320	427	512	631	721	857	753	603	502	322	199
Grains	142	185	256	220	163	365	399	412	330	292	177	146
Fodder	166	188	253	337	472	596	708	616	457	346	265	196
Winter Veg.	174	125	-	-	-	-	-	-	204	445	326	265
Summer Veg.	-	-	155	315	446	550	460	375	-	-	-	-
Total Composition of crop	685	818	1091	1384	1712	2232	2424	2156	1594	1585	1090	806

Source: Boheira Co.Ltd. Technical Report No.1 (Egypt,1970), p.19.

to their proportional importance is shown in Table No. 3.4.5. Assuming a 65%[37] irrigation water efficiency the irrigation water requirement for the crops in m^3/ha./month is shown in Table No. 3.4.6 on the further assumed periodicity of watering shown in Table 3.4.7.

Table No. 3.4.7

Crop	Period between individual irrigation per day
Fruit Trees	8
Grains	4
Fodder	5
Winter veg.	5
Summer veg.	3

Source:- Boheira Co.Ltd. Technical Report No.1 (Egypt 1976) p.23.

The leaching requirement was determined according to the formula (shown on p. 77). Consequently the water requirements for irrigation and leaching appears as in Table No. 3.4.8.

Table No. 3.4.8

Month	m^3/ha./day	m^3/ha/month
January	35	1085
February	44	1232
March	54	1674
April	69	2070
May	84	2604
June	113	3390
July	117	3627
August	117	3627
September	80	2400
October	88	2310
November	54	1620
December	41	1271

Source: Boheira Co.Ltd. Technical Report No.1 (Egypt 1970), p.21.

This results in a total demand of 1.95 m^3/sec. based on a 24 hour day irrigation system. The output from Tauorga springs (of 3.020 m^3/sec. minus 0.2 m^3/sec.) is thus sufficient to meet the total demand, but since the pumping station will work for 16 hours daily the demand will increase to 2.93 m^3/sec. This slightly exceeds the water supply (2.82 m^3/sec.) of the springs, the deficit to be compensated by a storage volume of 80,000 m^3.(39)

The chemical content of soil solutions or irrigation waters is usually represented in one of three ways; parts per million (ppm), milliequivalents per litre (MEG/L), or as electrical conductivity expressed in micromhos per centimetre ($ECx10^6$). In this thesis electrical conductivity expressed in mmhos/cm will be used. The chemical analyses made in March 1965 gave the following data:

Temperature	31°C
Specific conductivity	4.2 millimhos at 25°C
pH	7.4
Total hardness as $CaCO_3$	1333.8 ppm.
Total dissolved solids	2940.0 ppm.
SiO_4	24.0 ppm.
Ca	292.0 ppm.
Mg	147.1 ppm.
Na	494.2 ppm.
K	32.8 ppm.
HCO_3	296.5 ppm.
CO_3	-
Cl	914.9 ppm.
SO_4	846.1 ppm.
NO_2	0.004 ppm.
NO_3	20.7 ppm.
Fe	traces

The Sodium Adsorption Ratio (SAR) is 6; thus there is no sodium danger to plants. The water falls into class C4 - S2 according to the American classification.(40) Thus the water could be used for irrigation. However, all machines and steel which touch the spring water must be protected against corrosion, and high quality concrete must be used.

Further chemical water analysis for 16 samples are shown in Appendix - A.

3.5 Irrigation system [41] (Fig. 3.5.1)

Given the characteristics of the physical factors as summarised above, for the project area a flood irrigation method was proposed. The decision was taken to employ a basin flooding system, within which border strip and furrow systems could also be used as appropriate, for the following reasons:-

1) Due to the high salinity in the irrigation water and salt content in the soil only fairly salt tolerant plants with a relatively low commercial value can be cultivated. In relation to the high costs of a sprinkler system an economic success could not therefore be guaranteed.

2) The irrigation costs in the case of sprinklers would additionally rise because of the high proportion of water required for leaching; sprinklers are designed to supply water almost entirely to the plant and root zone and leaching losses are normally minimised (see also 3.2. - Soils).

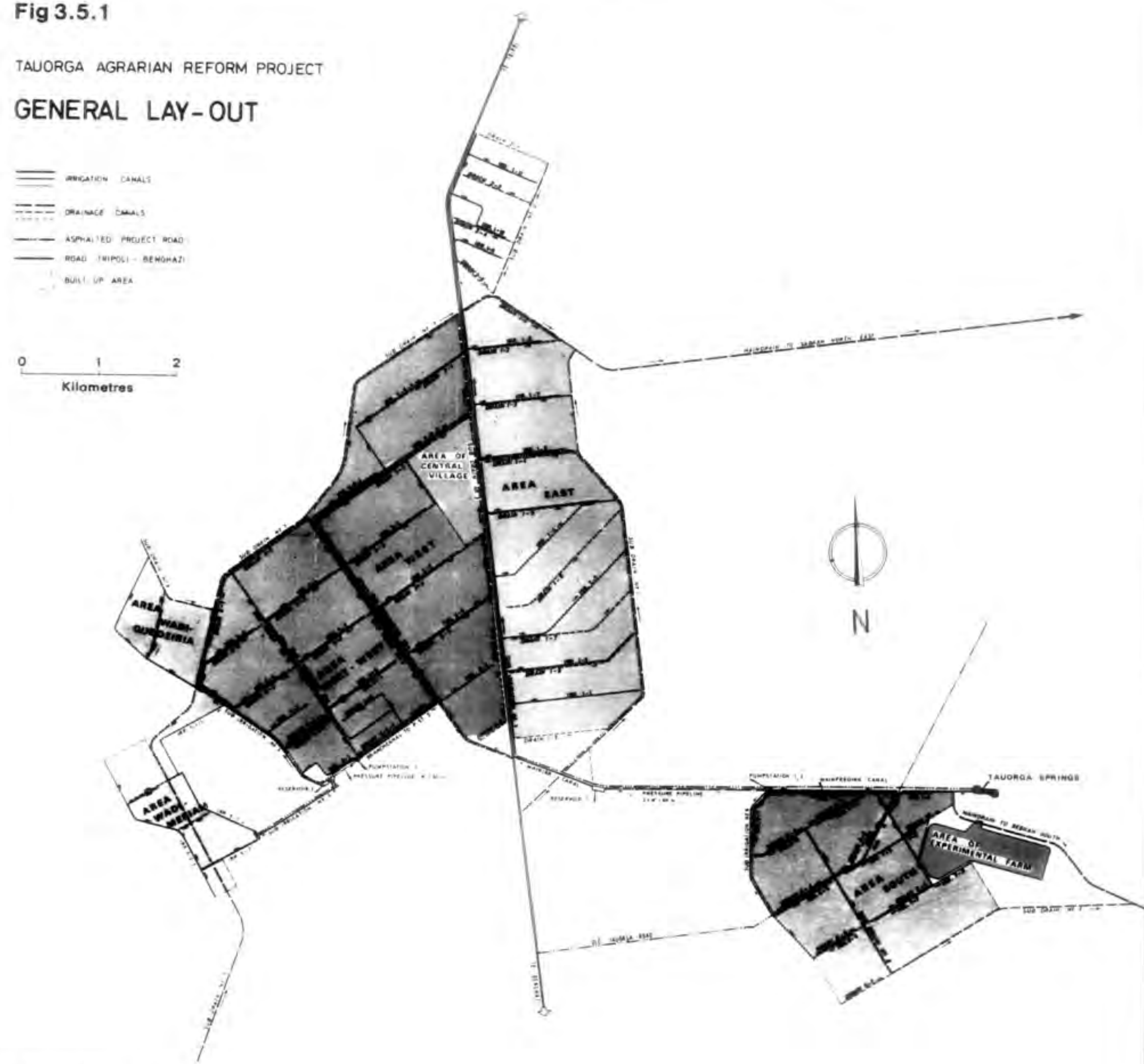
3) The plants would be more directly affected by solid residues (e.g.carbonates) if water was applied by sprinkler rather than by flood irrigation.

Given the two critical decisions, (a) to exploit a small number of water sources and (b) to utilise a flood irrigation system a number of important consequences followed. First, in order to ensure the maximum use of gravity-flow instead of pressure systems, a number of large elevated reservoirs had to

Fig 3.5.1

TAUORGA AGRARIAN REFORM PROJECT

GENERAL LAY-OUT



Source: Boheira Co. Ltd.

be constructed to provide flow-equalisation over the whole area. Secondly, given this, pumps had to be installed to fill and maintain adequate levels in the reservoirs. Thirdly, the general specifications for distribution systems from reservoirs to fields became fairly rigid. It is worth outlining here some of the engineering and construction requirements which then followed.

Because of the permeable upper loess soil layer, and due to the relatively long distances from the elevated reservoirs to the cultivated areas, lining of all the irrigation canals was required. The choice lay between a) the lining of channels with reinforced concrete by means of prefabricated open elements, b) a lining with a plain concrete coat on the surface of an open earth profile cut out of a compacted embankment dam. Except for the main irrigation canal and reservoirs Nos. 1 and 2 the Government decided on the execution of the latter for reasons of cost. Also, excluding the main feeder canal from the springs to the main pumping stations Nos. 1 and 2, all irrigation canals were designed as above with trapezoid cross sections.

1. Main Feeder Canal

Execution as open earth canal with gravel (15-20 cm) and rip-rap (layer of 30-40 cm) protection layers on the upper inner slopes of the canal section. The total length of the canal from the springs to the main pumping station Nos. 1,2 amounts to 2,600 m. where the canal is sloped constantly with a 0.2% gradient. The open cross section consists of a lower canal section of 3.00 m. bottom width and 1.60 m. depth and side slopes of 2.3%. Above this section a storage section is provided with 18.50 m. bottom width and 1.00 depth. Thus a total storage volume of

80,000 cu.m is available, this required for compensating for the deficit between springs' discharge and the actual demand.

For cleaning or maintenance purposes, etc. in Station Km 0+300 the canal section can be closed by sluices and the water of the springs can be diverted through a main drainage canal to the southern Tauorga sebkha.

2. Main Irrigation canal - heading from the elevated main reservoir No.1 to the main part of the irrigation 2,400 m. long. The bottom width of this canal is 3.00 m, the clear height is 1.75 m, side slopes have a slope ratio of 2:3 and the gradient is 0.1%. The thickness of the plain concrete lining amounts to 12 cm. and at intervals of 3m a sealed expansion joint has to be provided.

3. Sub-1 Irrigation canals - branching from the main canal respectively from reservoir No.3 or distribution chambers of PST 2 and PST 3 and supplying the sub-2 canals. These are constructed to carry flows of between 400 and 1,400 L./sec. according to the different sizes of trapezoid cross-profiles which are of bottom widths from 1.00 m. to 1.25 m. and clear heights from 1.20 m. to 1.45 m. The side slopes are a constant 2:3, and the gradient is 0.2%.

4. Sub-2 Irrigation canals - these canals, branching off the sub-1 canals and supplying the lateral irrigation canals are mainly constructed with a clear bottom width of 33 cm. and a clear height of 65 cm. The side slopes are constantly 1:1, and the gradient 0.4 - 0.5%; the flow amounts to 200 L./sec.

5. Lateral Irrigation canals - these canals, provided with outlets at regular distances of 110 m. for irrigation of the fields,

are constructed with a clear bottom width of 22 cm. and a clear height of 55 cms. The side slopes are constantly 1:1 and the gradient is generally 0.4 - 0.5%. Depending on the lengths of the different lateral canals the flow is graded between 80 and 120 L./sec.

6. Pumping Stations, Distribution Chambers, Elevated Reservoirs

Because of the height a.s.l of the irrigation areas, approximately 10 - 20m, relative to the level of the springs (deconfined water level : 5.800 m), the whole project depends on 3 pumping stations to lift water from its lowest to the highest level to get irrigation by gravity.

P.S.T. No.1

6 units each discharging 0.90 m^3/sec., 2 of them stand-by.

P.S.T. No.2

2 units each discharging 0.90 m^3/sec., 1 of them stand-by.

P.S.T. No.3

3 units each discharging 0.90 m^3/sec., 1 of them stand-by.

The PST No. 1 and 2 were constructed in one building to economize maintenance organisation and operation and to reduce the construction costs. PST No.3 represents an intermediate station to lift irrigation water to the highest project area in the west of approximately 14,000 cu.m. storage capacity. It is supplied by water of the elevated main reservoir R1 flowing by gravity to the station.

PST No.1 supplies an area of 2,400 via the elevated main reservoir R1 of more than 50,000 cu.m storage capacity.

PST No.2 with one unit directly supplying the enclosed area south of about 550 ha. via a distribution chamber only without storage capacity.

Reservoirs Nos. 1 and 2 are furnished with electrodes controlling the corresponding pump units depending on the water-level in the elevated reservoirs. With automatic gates at the outlet of each reservoir the outflow of irrigation water can be controlled according to the requirements.

The reasons why the flood irrigation method was proposed are considered on (p.71).

The salts contents and the textural characteristics of the project soil, the dry climate and the type of crops all determine the quantity of water requirements for irrigation and leaching. This quantity and quality of the required water determine the capacity and structure of the irrigation system. The capacity and structure of the irrigation system has to be large and strong in order to cope with the required huge water quantity, and a specific cement type has to be used due to the water quality. The critical point of assured water supply to plants, especially in summer, demands stand-by systems and high quality engineering specifications.

The bottleneck in the irrigation system is to guarantee the electrical power supply for 16.0 hours a day to ensure unfailing supply. These together determine the type and efficiency of the drainage system. These points illustrate the way in which environmental factors specific to the project area influenced and, in part, determined the physical layout and constructional characterists of the irrigation system, which in turn also became physical determinants of other variables.

3.6 Soil-water relationship - leaching

Due to the high content of salts in the soil project area, only relatively salt tolerant plants can be cultivated and in several areas of the project area deliberate leaching is necessary before cultivation.

Except for the Wadi Meriam area i.e. Hosha Nos.16 and 17 of 120.6 ha. (Fig. No. 2.1.2) where soil is not saline (1-3 mm hos/cm at 25°C for soil past extract); (42) the rest of the project hoshas of 2162.98 ha. are saline soil, high to very high (5 to 138 mm hos/cm at 25°C) (43) Leaching requirements of hoshas and their sizes are shown in Table No. 3.6.1 below:-

Table No. 3.6.1

	Leaching required				Leaching not required	
	No. of hosha	Size of hosha	No. of hosha	Size of hosha	No. of hosha	Size of hosha
	1	63.2	18	105.5	16	58.8
	2	105.5	19	53.0	17	61.8
	3	77.9	20	98.0		
	4	75.6	21	97.3		
	5	75.3	22	79.5		
	6	54.4	23	66.8		
	7	30.1	24	67.1		
	8	95.3	25	39.2		
	9	66.5	26	34.7		
	10	69.5	27	40.8		
	11	78.1	28	38.9		
	12	31.6	29	45.1		
	13	58.1	30	117.3		
	14	44.4	31	109.5		
	15	101.9	32	142.7		
		1027.4		1135.4		120.6
	Total	2162.8				120.6

The leaching water requirement was determined according to the formula

$$LR = \frac{ECw}{ECdw} \times 100 = \%$$

Where:- LR leaching requirement

ECw electrical conductivity of irrigation water (in mm hos/cm).

ECdw electrical conductivity of drainage water.

Accordingly $LR = \frac{4.2}{8.3} \times 100 =$ about 50% of the water consumption of the plants.(44)

The very high permeability of the loess layer and high solubility of the salts make leaching possible since the drainage conditions could be made adequate, if proper management is available, accurate levelling can be performed and labourers are trained etc. Without leaching, salinity would remain at a prohibitive level and therefore a number of specific requirements have to be met. First, not only creating a root zone free of salt, but pushing the salts into a critical depth in order to permit the commencement of the next activity i.e. reclamatory cultivation. The technical specifications and the required works for leaching are shown on pp.126-131.These, in turn, dictated a demand for additional labourers and experienced technicians. Secondly, there can be identified a feedback to the construction phase. The comparatively huge additional quantity of leaching water requirements i.e. to plant water requirements and loss by evaporation and seepage necessitated the construction of large irrigation canals to bring the total required water from one single water resource to the whole project area, and the construction of large drainage ditches which will drain the water from every part of the project area, concentrating the flow and carrying it to an area outside the project. Consequently the unavoidable construction specification of the irrigation canals and ditches raises the question of fixed and current capital expenditure, technology and technicians to construct, operate and maintain them, as we shall see in Chapter four.

3.7 Drainage system [45] (Fig.3.5.1)

As we have seen leaching is very essential, yet to get rid of the drained water is just as important as leaching. The ground water table must be kept below a specific depth, otherwise the cultivated plants will not survive and re-salination will take place. For this reason and due to the absence of good natural drainage, in spite of soil permeability the construction of an integrated drainage system is necessary. The technical characteristics of the drainage system may be summarised as follows:

Within the main system lateral drainage canals had to be constructed 135 m. to 150 m. apart. Additional to the lateral drains are smaller field-drains being fed at regular distances of 110 m. with an average depth of 1.00 - 1.200 m. Sub-2 intermediate drains collect the water from the laterals and transport it to the sub-1 drainage canals which in turn deliver it to the main drains. From there the water will flow off through two principal drains, dewatering into Tauorga sebkha areas in the North-East respectively in the South-East.

Generally all drainage canals are dimensioned for flows of between 0.3 to 0.6 m/sec. A small number of bottom falls were required in the larger canals only, executed by plain concrete. As with the distribution canals, the open drainage system requires further construction of bridges and culverts to carry the dense network of service roads as well as various forms of protection against flood erosion etc. The reasons for choosing an open as opposed to a closed drainage system were similar to those affecting the distribution system, but the decision itself has further consequences in determining the demand for maintenance. Even more than with the distribution canals, the open drains which are very rarely completely dry are more difficult to keep clear from growing plants or windblown silt and sand.

Conclusion

In this chapter the most significant physical factors involved in and affecting project implementation have been described and the implications of each for the establishment and operation of the project briefly indicated. Their interaction and relationship to other factors of production is considered more fully in Chapters Four and Seven.

Here one can indicate the degree to which some of the physical fixed variables can be evaluated for significance.

First, the project is based on irrigation agriculture. The water for irrigation is obtained from what is essentially one single source and consequently must be distributed over the farmed area in an extensive integrated network of distribution canals. Secondly, since the soils most suitable in terms of texture lie on the rising ground to the west of the Tauorga springs source water must therefore be pumped to the elevation of these higher western levels and some storage/balancing reservoirs have to be built. Thirdly, the high but not extremely high evapotranspiration rates, together with - and much more important - the soil characteristics of a high content of soluble salts which have to be leached from the plant root zone, set the minimum limits for water application rates. Further, not only the volume of water applied, but also the method of application of flood irrigation and the frequency of application, are governed by this high leaching requirement, Fourthly, since about 95% of the irrigated area was virgin land before the project started, land reclamation involved levelling in order to produce areas suitable for flood irrigation. The poor and spatially variable development of soil structure and the shallowness of the upper horizons, in some areas above the less permeable and lower nutrient content underlying marls, in many places restricted the scale of levelling operations. Together with the spatial distribution of soil types in the area this determined the location of the blocks of land for reclamation for irrigation agriculture. Fifthly, an absolute necessity for the construction of an extensive integrated network of drainage canals results from the application of water to meet the requirements noted above and the limited vertical infiltration through most soil and the higher water table in the eastern zones of the project area. Used charged water has to be collected and transported to land of less value outside the project area.

Once the decision was made to establish a rural resettlement project on the basis of irrigated agriculture, those five key factors fundamentally influenced all other aspects of design, construction and operation.

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CHAPTER FOUR

ECONOMIC, SOCIAL AND ORGANISATIONAL FACTORS OF PRODUCTION

Given a resettlement scheme based on productive irrigated agriculture on newly reclaimed land, one must now examine, in the context of the land factor considered in Chapter 3, the other factors of production.

Since the project is one involving new rural settlement the need arose for planning residences for the 300 colonist farmers, together with the provision of buildings for the various services, utilities etc. that were to be provided to underpin the project for the new community. The decision taken was to build a central village which would accommodate all these functions, to be located on the main Misurata-Sirt road and approximately at the centre of the main reclaimed area.

As we saw in Chapter 3, large-scale leaching is necessary before cultivation; this in turn requiring land levelling and the installation of a drainage system long before actual irrigated cultivation.

The soil also, we have noted, has poor structure in most of the project area, so it is in need of reclamatory cultivation which consequently lengthens the period of capital input for purchasing the necessary equipment, e.g. machinery, as the machinery purchased for the execution of the first phase cannot be used for agricultural purposes, and purchasing specified seed which would produce big shoot systems to be ploughed under as a green manure etc. as well as making great pre-production phase demand for specialised labour.

For the project area the flood irrigation method was proposed (p. 71) This type of irrigation system , as outlined in Chapter 3 requires a considerable amount of capital (Table 4.1.1) due to the fact that it is necessary to line all the irrigation canals with concrete to avoid severe water loss as well as resalination caused by soil permeability, and canal structural damage caused by soils which are mechanically weak when water-logged and by erosion. The chosen irrigation flood method also requires a large number of production field workers (Table 4.2.1) In general, the number of labourers for irrigation depends upon the crop, type of irrigation system and planting layout, e.g. strip, basin or furrow. The leaching method necessitates a quite considerable number of labourers, in fact about 10 labourers/ha. per day to build up and strengthen the embankment of the strips raising them to a height of more than 15 cm. Furthermore, it became necessary to detail 5 labourers per djosa (c.1 ha.) during the leaching processes in order to control the water because of the poor structure of the soil. The frequent breaking and cracking of the irrigation canals needed a force of labourers (pp. 224-226) to carry out the permanent maintenance of irrigation and drainage canals as well as to maintain the central village.

Because of the Ghibli, a hot, dry desert wind, and the absence of protection from high mountains (pp.48-49) windbreaks became necessary. This requires the purchasing and transporting of seedlings and cuttings and which in turn necessitate drilling holes for planting, and having channels and pumps for irrigation and fertilization. The irrigation of the inner and outer windbreak trees requires labourers to supply and control water and for pruning.

Although the farming system in the project at present is running as one unit, operating directly under government instruction, the plan assumed that the holdings would be distributed to farmers to be run as private enterprises with some management control by the government through the co-operative societies etc. This decision to establish up to 300 eventually independent private farms has clear implications not only for the layout, but also the management and organisation of project production, marketing etc.

The complex processes by which the farmers have to come to terms with physical and economical factors in order that their efforts can be transferred into goods or services needs management (p. 107) to organise and control exploitation of such saline soil irrigated by salt water. Furthermore, such conditions call for specialist 'know-how' for leaching, reclamation, machinery application and the choice of the right crop for this project, climatically suitable and bearing in mind the further restrictions imposed by soil and water conditions. Administrative arrangements are also needed to deal with the payment of wages, health costs, insurance etc. to labourers and employees. These and other aspects of factors of production are examined below under four main headings of capital, labour, human skills and management.

4.1 Capital

Introduction

Resource exploitation requires both minimum volumes of expenditure and certain types of expenditure - as we shall see. Normally, if such expenditure is incurred in order to achieve viable productivity, with all that this implies, we refer to it as investment - with an expectation of some measurable return.

The exploitation of resources in order to achieve objectives which are not only commercial and financial may allow the question of full economic viability either to be ignored or given low importance. As we shall see in Chapter 5 the Tauorga project objectives included general social desiderata as well as the specific production of marketable commodities. This is not unusual in L.D.C. development projects and the problem of applying the discipline of cost-benefit ratios in such situations is a common one. This problem is not central to this study and will not, as such, be dealt with.

However, the fact that the strict application of the concept of investment, implying a calculable return on that investment, was <u>not</u> utilised in pre-investment decisions, project design and project implementation at Tauorga is highly relevant. The capital for the project was supplied by the Libyan state which has tended to regard all revenue from whatever source as disposable income, and, as with many other oil-exporting, capital surplus states (Al-Kuwari, 1978) has not drawn a very clear line between capital investment and current expenditure.(1) As we shall see, the absence of any very firm financial or economic discipline has affected many aspects of the project.

In the Libyan situation, in agriculture in this case, the question of maximising returns and therefore the need for carefully evaluating investment opportunities including resource evaluation, this in terms of limited capital availability, did not arise. Instead there was the basic attitude of capital being available for expenditure. The approach therefore was as follows:

(a) The identification of an under-used resource, in this case unused water and land.

(b) To declare that this will be used for general socio-economic benefits with emphasis on higher quantity and quality of consumption i.e. housing, incomes, services, education etc.

(c) To make technical (not investment/return) studies of what was needed for this.

(d) Lastly, to allocate capital and to employ implementation agencies.

These points clearly relate to the nature of approach to land factor as we have seen. Expenditure on technical studies, the design of irrigation, drainage, central village, agriculture land preparation, etc. were accepted as necessary fixed costs with no reference to returns. This expenditure on agriculture physical infrastructure was determined by the nature of resources and characteristics of environment, (see Chapter 3). Other expenditures on other infrastructures were open to some choice, but the choice was limited by social element of policy i.e. superior housing, large agriculture schemes, etc. However, before analysing the capital allocated for this project it is worth distinguishing between two types of capital expenditure inputs.

1. Fixed capital : Those expenditures whose effects and costs are fairly constant or change only over a period of years with change in technology. (2) This type of capital affects the whole project and it is difficult to allocate costs to individual enterprises. (3) Concerning the project under investigation this type of fixed capital includes items of construction, e.g. the central village, irrigation system, drainage system reservoirs, pumps and machinery. It becomes difficult and/or artificial to attempt to relate net returns to individual enterprises by setting fixed capital expenditure against total production.

2. Current expenditures directly affect individual enterprises and their cost can therefore usually be allocated more easily. (4) They include seeds, fertilizers, chemicals and temporary labour etc. Such costs may be subtracted from the gross output or total income per unit area from each enterprise to arrive at the net income.

The Libyan government accepted the responsibility to supply finance for all capital expenditure in both the first and second phases and to subsidize the third phase (production phase) both in capital and current expenditure terms.

Capital Allocation

1. The First phase - included the studying of water resources and climate, soil investigation and planning of the project etc. These cost about LD 150,000. (5)

2. Second phase - Stage 1 - construction: the total original value of the contract amounted to LD 7 m divided into: (6)

a) General works LD 2.1 m
b) Reformation works LD 3.9 m
c) Central village LD 1.0 m

But, final value of the contract increased to a total of approximately LD 8,300,000. (7) It is apparent that there was about LD 1,300,000 expended more than the original allocation value. Table No. 4.1.1 below shows the breakdown of this expenditure

Table No. 4.1.1 Expenditure on second phase - Stage 1

No.	Item	% of provided money	Expenditure of capital L.D.
I	Irrigation, drainage and land preparation scheme	83.64	6,942,120
II	Windbreak trees	0.09	7,470
III	Employment and some farm houses	9.14	758,620
IV	Equipment for drinking water supply	1.15	95,450
V	Electrical equipment for supply of the farm area	3.60	298,800
VI	Establishment of the central village	2.38	197,540
	Total	100.00	8,300,000

Source:- Speetzen, H. Land Settlement Projects and Agricultural Development Ph.D. Thesis(1974),p.463.

Items II, IV and V were not taken into consideration while allocating capital and although Boheira Company started to execute this stage in 1970, the Consultants - WAKUTI was asked to return to supervise Boheira Company on March 1972 and consequently the cost for that was not considered. Furthermore, the international increasing of prices of construction materials during the original and the prolongated period of this stage contributed to over-spending.

3. Second phase - Stage 2 - as soon as the second phase - Stage 2 of the project, including leaching, reclamatory cultivation etc. all necessary for the establishment of agriculture started, new

expenditure and investment capital was necessary for, e.g. machinery for agricultural processes, seeds, fertilizers and wages etc. all the cost of which is supplied by the Libyan government.

The expenditure on this regular input included both fixed capital (equipment, machinery etc.) and current expenditure (over approximately 4 years) on seeds, fertilizers, fuel etc. and central operations of the project.

The exact final costs are not known because this stage is not yet finished, but at a preliminary estimation it is about LD 2.619 m.[8] Estimated breakdown of those costs are shown in Table No. 4.1.2 below:

Table No. 4.1.2 Expenditure on second phase - Stage 2

Item	Cost L.D.	Remarks
Machinery	515,200	
Consultant Office - WAKUTI	132,000	Period from March 1975 - March 1977
Total fixed capital	647,200	
Fertilizer	134,274.5	
Seeds	171,720	
Fuel	86,400	
Labourers	929,695	
Agronomists - foremen	300,033	
Administratives	98,713	
Drivers	152,703	
Technical staff	99,000	
Total current capital	1,972,538.5	
Grand Total	2,619,738.5	

Furthermore, in July 1977, the other items shown in Table No. 4.1.3 appeared to be necessary. These were either originally not costed, such as item No. 1, the result of modifications such as enlarging capacity such as item No. 2 and part of item No.3, or for purpose of protection such as the other part of item No. 3.

Table No.4.1.3

No.	Item	Value L.D.
1	Establishment of soil analysis Laboratory	88,651.810
2	Establishment of machinery warehouse and protector	59,737.715
3	Establishment of walls around the springs and the houses	59,607.900
4	Establishment of the remaining 200 settled houses	965,617.5
	Total	1,173,614.9

Source: The Libyan Secretariat of Agriculture Achievement of the Revolution from Sept. 1969-Sept. 1978, (Tripoli 1978), p.132

4. Production phase - At the end of and overlapping with second phase - stage 2 was the planned takeover by the settlers and the production phase. Based on Libyan agriculture policy in similar reclamation and settlement projects such as the Hadhba Khdra settlement project (5 km. south of Tripoli) it was expected that when the Tauorga project land is distributed the settlers will be supported by an agriculture cooperative society, financially supported by the government through the agricultural banks. The agriculture cooperative society budget would be based on the following income:-(9)

1. Contributions of or levies on participants in the enterprise i.e. paid by the farmers (members of the agriculture cooperative society).

2. Charges made by the agriculture cooperative society to farmers against work executed for them, based on per land unit or on a percentage basis of cost against transport based on a percentage basis of costs.

3. Loans from the agriculture banks.

4. Subsidy from Ministry of Agriculture and Agrarian Reform. In principle subsidy is paid mainly during the period of establishing the agriculture cooperative society.

5. The 3% commission which the a.c.s. retained as investment saving for producers. (10)

As noted on p. 91 this would conform with existing general policy statements and the practice tenable at Hadhba Khadra agricultural project. At Tauorga the efficacy of this way of meeting central recurrent expenditure can not be evaluated yet. Concerning the expenditure, costs of the constructed central village, drainage system, irrigation system, equipment, machinery, reclamation, operations central administration and management etc. are paid by the Libyan government.

The first and second phase (Tables 4.1.1 - 4.1.3) total expenditure incurred is estimated by the end of 1977 at L.D. 12,243,352, this to bring 3,000 ha. only partially into a state ready for handing over to settlers, i.e. about L.D. 4,081.12 per ha.

The Libyan government charges no interest on capital expenditure, either fixed or current, not on grants or subsidy or other central expenditure expected. Moreover, the settlers would be provided with free housing and would pay only 25% of the basic costs of the land holdings.[11] The actual terms of repayment by settlers will never be known since allocation has not taken place.

CONCLUSION

1) The first allocation of capital for the second phase - stage 1 was meant to be specific, but due to the absence of accurate estimation of the required capital and due to the poor forecasting of required consequential works, and due to delay in construction as prices increased, this specific allocation turned to be open-ended.

2) Actual expenditure over-ran sums allocated to phase 2 - stage 1 and an additional L.D. 1,300,000 was required; a further additional of L.D. 1,173,614.9 was required to complete the project construction. In Libya, abundant oil revenue managed to overcome this problem, but for other countries it might make it impossible to complete constructing the project. Furthermore, if it is apparently easy today for Libya to overcome the problem of finding capital, it is achieved only by running down the capital resource, non-renewable of oil.

3) Giving free houses and charging the settlers only 25% of the farms expenditure costs and the provision of grants, loans subsidies etc. without interest or a concern about return on fixed expenditures are destroying the opportunity of capital generation.

4) The total expenditure cost to bring one hectare in the Tauorgan project, into a state ready for handing over to settlers so far, is about L.D. 4081.12; this figure is 76% more than the expenditure costs of a hectare in Hadhba Khadra project i.e. L.D. 2310 per hectare.[12]

The wide difference of expenditure between those two projects is mainly due to the nature of the soil and surface geology. First, the Tauorga project suffers from problems of sink-holes which do not exist in the other project. Secondly, leaching processes in the Hadhba Khadra were more effective than in the Tauorga project because the soil texture [13] in the former is sandy silt, the sand fraction composing between 85-90% by volume while the soil texture in Tauorga is varied (p. 52), but almost everywhere less permeable.

4.2 Labour

Theoretically, labour is a highly divisible factor of production as its input may be varied in several different ways[14]

1. In units of one whole-time worker.
2. By the use of part-time personnel.
3. The regular labour force may work overtime or short-time.
4. Casual labour may be employed.
5. A firm that has excess work in hand may sub-contract some jobs.

In practice, however, labour input is less divisible than this classification would suggest, particularly on small farms with single household settler holders.[15] In such cases the farmer has little room for manoeuvre as each family member of hired labourer represents a sizeable proportion of the total work force, and in the case of the family member cannot be treated as a time-variable employee. The labour classification which will be applied here is as follows, this excluding skilled technologists, managers and administrators:

1. Farm production workers:

   a) The required number of candidate settlers.

   b) Permanent, fulltime, agricultural labourers, who could be employed by the settlers if required.

   c) Casual agricultural labourers, who will be employed by the settlers if required.

2. Permanent agricultural but non-farming labour force for operating the irrigation system, maintenance of the project etc.

3. Non-agricultural labour force such as that required for social services etc.

Except for 1 b and c above, which will be considered in Chapter No. 5 all items above will be treated in this section.

The level of labour input per unit of land or capital depends on its availability, its cost and the need to achieve a given level of output.

Different numbers and levels of skill of workers were required to execute the different phases of this project are as follows:

First phase: About 24 workers were required during this phase to carry out soil sampling by augers, digging soil profiles etc. These labourers were employed as full time and their employment expired when this phase was completed.

Second phase - Stage 1: About 700 labourers, both Egyptian and Libyan, were employed as full time labourers to perform this stage.(16 Except for 240 of the Egyptian labourers the employment of the rest expired when this stage was almost completed. Most of the Libyan labourers continued to work in the project as the next stage started.

<u>Second phase - Stage 2</u>: For the execution of this stage there were needed about 582 labourers of three different nations i.e. Libyans, Egyptians and Tunisians.

Some of the Libyan labourers working at this stage on the project were planned to be the farmers of the future i.e. the settlers based on the provisions of the law No.123 for the year 1970 (pp 43-44).

<u>Production phase</u>: In this phase the required number and duties of the permanent agricultural and non-agricultural labourers can only be estimated since full plan implementation did not occur. However, attention in this section will be concentrated on labourers for phase 2 - stage 2.

There are about 582 labourers employed for phase 2 - stage 2 who are distributed on the following tasks as shown in Table No. 4.2.1

Table 4.2.1 Labourers employed for the Second phase - Stage 2.

	Item	No.of labourers	Remarks
1	Irrigation - 8 labourers per Hosha	256	Labourers could be transferred to another enterprise such as leaching or loading and unloading fertilizers
2	Leaching	120	
3	Windbreaks		
	a) Inner windbreaks	32	
	b) Outer windbreaks	45	
4	Main and sub-l-irrigation canals and reservoir control	13	
5	Unloading and loading bales	6	
6	Attendants on bailers	10	
7	Pump stations, workshop, store and trees	13	
8	Labourers' foremen	8	
9	Store labourers	6	
10	Water cleaners (to get rid of grasses to avoid damage to pumps)	5	
11	Laboratory labourers	6	
12	Maintenance labourers	62	TPSC labourers
	a) team for joint sealing material		
	b) " " earth works		
	c) " " concrete		
	Total	582	

All labourers, except in item 12(refers to TPSC maintenance work), have annual contracts as farm workers with the GCMAP which undertook the execution of this stage. Of the 582 labourers in total, 325 were Libyan, 240 Egyptian and 17 Tunisian i.e. over 41% of the labourers were non-Libyan.

Labourers salary levels of L.D.75 and L.D. 60 per month were fixed by the government as a minimum wage for the Libyan and non-Libyan respectively. The L.D. 75 rate was liable to the following deduction. (17) 8% income tax, 3% Jehad tax and 0.5% health and social insurance payment leaving about L.D. 64.98 per month (for unmarried childless workers) as net wage. The total wage bill for labourers in the second phase - stage 2 was L.D. 929,695 in total (see Table 4.1.3) The poor availability of skilled and specialized workers reduced productivity per head and madenecessary a numerically large labour force - there is a Turkish proverb "He who hires cheap, hires dear!". In addition, the seasonality of agricultural processes and climatic conditions produced periods of peak demand e.g. pre-irrigation, levelling, leaching, sowing etc. produced a large additional wage bill for overtime. Except for the expatriate contract labourers the rest were Libyan nationals on local contract working for the company; the hiring of expatriate labourers however did not mean that there were necessarily no labourers available in the Tauorga area, on the contrary the Tauorga population was then about 8,698 (Table 3.2.1) and it then appeared that new project opportunities would attract workers.

Here it becomes necessary to distinguish between the types of demand for Libyan labour, i.e. candidate settlers, permanent agricultural labourers and non-agricultural labour needed for this project.

Table No. 4.2.1, items Nos. 3, 4, 7, 9, 10, 11 and 12 show the total number needed as permanent project agricultural labourers as 182. Since, however, the total number of Libyan labourers in the project was only 325, this left only 143 labourers who could be considered as potential settlers, contrasting with the government policy of finding 300 farmer families from the Tauorga region. We therefore have to consider the Tauorga region population as a potential labour supply. Totalling some 8,698 inhabitants(Table 3.2.1), 45.7%* could be assumed to be older than 18 years. If we apply the 1973 vital statistics information of a male sex ratio per 100 females of about 108.7% this would lead to the conclusion that the size of adult male labour pool in Tauorga region was 2,158. Given the underemployment noted in the early surveys (see Chap.2) it should have been possible to find another 157 farmers and a further 100 labourers to fulfil the required number of 582 from the Tauorga region. Theoretically all 257 could have been agriculturalists as there were 1,156 agricultural holders out of the adult male labour pool.

In spite of this hypothetical availability in the Tauorga region, a shortage of labour was experienced in the middle of 1977 when the Egyptian and Tunisian labourers left the country (p.224).

Labourers for non-agricultural services e.g. electrical work, cleaning and other social provision, would also be required. It was assumed that they would be provided by the electrical authority of Tauorga, cleaning would be the responsibility of the municipality of Misurata, health services in the hospital in the central village by the Department of Health of Misurata and the post office services by the postal and wireless communication of Misurata. Thus the central village services of a non-agricultural kind will be supplied through a municipality type

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*Worked from percentage distribution of total population, urban and rural population by sex and age groups, 1973 (18) arrangement and integrated with regional provision of these services. However, no manpower need assessment was made and it was merely assumed that the workers would be forthcoming. Unfortunately the once-for-all expenditure on labourers on the first phase and the second phase - stage 1 is not known, but certainly was totally covered by the government. Concerning the current expenditure on labourers in the second phase - stage 2:

A. Part of this is 'once for all' expenditure in final preparation of land and the establishment of farms i.e. L.D.929,694, 35.5% of the grand total of the expenditure on phase 2 - stage 2 so far.

B. Part will be permanent recurrent expenditure in the provision of services to the agriculture production sector of project as the production phase starts .

i) Permanent labourers mentioned in Table 4.2.1 item Nos. 4, 5, 7 and 9-12, i.e. 182 labourers.

ii) 20 permanent labourers for agriculture production services who will be required for storing, marketing and central handling.

iii) 15 permanent non-agriculture labourers for social services.

As far as the cost of agricultural labourers in the second phase - stage 2 expenditures (A above) this was covered by the Libyan government and no returns were expected i.e. was written off. Of course there were several benefits such as the experience which the labourers were gaining is highly advantageous for, and only for, those labourers who would become farmers and wholly be required for permanent labour farm and farmers; and also the soil improvement in some parts of the project.

But, how would this permanent non-agricultural and agricultural recurrent expenditure on labourers as distinct from farmers, candidate settlers be met in the future?

The 15 permanent non-agricultural labourers (iii) above would be paid by authorities to which they belong. The permanent agricultural recurrent expenditure on about 182 labourers (i) above, and the 20 permanent labourers (ii) above would be paid by the agriculture cooperative society.

However, when the second phase - stage 2 would be completed the production phase would start and new labourers with new different specific skills would be required. The expected labour force requirements for the production phase was then as follows:-

1) 300 farmers, candidate settlers.
2) 900 permanent agricultural labourers to be employed by the settlers (pp.194-198).
3) 202 permanent agricultural labourers i.e. 182 labourers mentioned under item Nos. 4, 5, 7 and 9-12 in Table 4.2.1, and 20 labourers for agriculture production services.
4) 15 permanent non-agricultural labourers for social services.

Thus the overall required number for this phase was 1,417 labourers; this means that an additional 835 permanent labourers must be supplied over and above the existing 582 labourers.

SUMMARY AND CONCLUSION

1) The 582 labourers identified in Table 4.2.1 as working on the second phase - stage 2 hypothetically could have been drawn from the adult male labour pool in Tauorga region i.e. 2158 and there was a possibility that they could be agriculturists

drawn from the 1,156 agriculturalists in the region.

2) The question arises why then were there 257 Egyptian and Tunisian labourers employed in the project? The explanation can be found in the following definition and explanation :

"Labour economists now define the supply of labour as the amount of work supplied by a given population" (19)

The amount of labour supplied by a given population depends on four factors (20)

1. The labour-force participation rate.
2. The number of hours people are willing to work per week or per year while they are in the labour force.
3. The amount of effort workers put forth while at work.
4. The level of training and skill that workers bring to their jobs.

3) The further requirement of 835 labourers for the production phase again was hypothetically possible to draw from the adult male labour pool of the Tauorga region. But the overall required number, except non-agricultural labourers, i.e. 1,402 first, exceeds the total number of agriculture holders in the Tauorga region and secondly, it is not realistic to assume that all the agriculture holders will be interested in working as agricultural workers in the project; thus those labourers who might be found from the Tauorga region were bound to include many without farming experience, making selection and training even more vital.

Clearly, the assumption made in the earlier plans and design concerning all aspects of labour demand and supply were not valid. As we shall see in Chapter 5 this miscalculation itself had severe effects on the project, although again we shall never know how the shortage of settler farmers would have been dealt with because for a complex number of reasons, including labour, land allocations were never made.

Most of the 325 Libyan manual farm workers in the project were questioned about whether they would like to be settlers in the completed project and their answers were:

a. 70% of them would like to be settlers.

b. 30% did not wish to be settlers in general because they do not like to be restricted and they believed that after some training in the project e.g. tractor driving or other machinery, they could get better salaries in other construction works.

However, 95% of that 30% would wish to be farmers provided that under the project land distribution, they would be given farms of their own and operate them in the way they liked. However, according to the observations made on the site, as far as the labourers are concerned, it could not be recommended to distribute the project lands immediately, but that this should be postponed until the candidate labourers have adequate experience in agricultural activities.

4.3 Technical skills and technological requirements:

A large number of agriculture projects for the exploration and exploitation of natural resources since 1970 have substantially altered the face of agriculture development in Libya.

The Libyan government realized that in order to achieve the objectives mentioned (in Chapter 5) the necessity of replacing the existing traditional farming and the increasing of the area under cultivation are unavoidable. Thus the task was the establishment of and operating an integrated agricultural settlement project, and consequently the erection of civil works and the construction of roads, irrigation and drainage systems etc. arose with a basic requirement for technology, technologists and managers during the first stages of design and construction.

The required 'know-how', technicians and technologists who were in charge of the project implementation, noting that the second phase - stage 2 is considered separately later (pp. 125-152), were as follows -

<u>First phase</u>:- A need for experts and technology to carry out reconnaissance investigation studies of the five key factors, see Chapter 3. Those experts and their equipment were imported from three different countries i.e. U.K., West Germany and Egypt in 1960, 1965 and 1970 respectively

The results of these three studies were submitted to the Libyan government.

<u>Second phase - Stage 1</u>:- According to study findings and their setting in the context of other factors of production, the decision of the high planners of the Libyan government was to construct the project. Thus the second need followed for experts, technicians, administrators and technology etc. for the project construction. However, due to a deficiency within Libya of the required elements for construction and civil works an Egyptian Company with its experts, technicians, machinery and equipment etc. was imported for this stage. Furthermore a team from W.Germany, WAKUTI, was imported to supervise the activities of this Company on behalf of the Libyan government. About 50 engineers and 100 craftsmen were required to perform this stage.[21]

<u>Second phase - stage 2</u>:- As this stage included leaching and reclamatory cultivation etc. yet more and different experts, technicians, administrators and machinery were required. Table No. 4.3.1 below shows the GCMAP employees staff, except for labourers, in charge in this stage.

<u>Table No. 4.3.1</u>

Item	Total No.	Libyan		Expatriate	
		No.	%	No.	%
1. Agronomists	20	3	15.0	17	85
2. Administrative staff					
a) Accountants	3	1	33.3	2	66.6
b) Typists	6	3	50	3	50
3. Drivers					
a) Tractor drivers	42	40	97.6	2	2.4
b) Car drivers	16	16	100	-	-
4. Technicians					
a) Pumping station staff	6	4	66.6	2	33.3
b) Mechanics	21	13	61.9	8	38.1
c) Mechanical & Electrical Engineers	2	-	-	2	100

TPSC supported with WAKUTI have to supervise and follow up the works executed by the GCMAP. The TPSC has also carry out the maintenance works in the project. The TPSC has the following employees:-

Table No. 4.3.2

For supervising and following up the works:-

Item	Total No.	Libyan		Expatr-iate	
		No.	%	No.	%
1. Agronomists	6	3	50	3	50
2. Administrators					
a) Accountants	4	1	25	3	75
b) Typists & clerks	4	-	0	4	100
For Maintenance Works:-					
a) Engineers & foreman	3	1	33.3	2	66.6
b) Heavy machinery drivers	10	7	70	3	30

WAKUTI's team consisted of the following members:-

2 agronomists

1 agronomist/pedologist

1 civil engineer

1 mechanical engineer for two tours of duty of one month each year

1 translator/typist

A shortage of agronomists, technicians and administrators occurred for this stage due to the fact that many employees left the country during the middle of 1977 (see p. 233).About 378 major items of machinery and equipment were required so far for implementing this stage - see Table 5-1.3.5.

The fixed and current expenditure on know-how, agronomists, technicians, drivers and administrators through all the project phases were paid directly by the Libyan government or indirectly by its agencies or contractors. For the second phase - stage 2 the expenditure on wages only of those employees so far is L.D. 782,449 i.e. 30% of the grand total shown in Table No. 4.1.2. The machinery and equipment expenditure so far is L.D. 515,200 i.e. 20% of the grand total shown in Table No.4.1.2.

CONCLUSION

Undoubtedly, the physical factors and the other factors of production are mere statistics unless we add human skills to investigate and analyse the results, design and construct the project, and then operate it.

Libya, as is also the case of any other underdeveloped country, has a deficit of experts, qualified technicians and technology. Thus the project's requirements for these have to be imported during all the project processes i.e. from the feasibility study until the second phase - stage 2.

Table Nos. 4.3.1 and 4.3.2 show the percentage of Libyan and expatriate skilled employees for this stage. The percentage of expatriate agronomists in both tables mentioned above are especially remarkable and serious because the later stages were vitally concerned with agricultural activities which were completely dependent on expatriates who were irreplaceable when they left the country.

4.4. Management and Organization

Project management may be defined as the science and art which deals with the operating and organizing of the project given physical factors and the other factors of production in a manner which would secure the greatest continuous profit.

1. <u>First phase</u>:- As the first phase included the study of soil, water and climate there is no real or important role for management.

2. <u>Second phase - Stage 1</u>:- This stage was executed by the Boheira Company according to a contract with the Libyan Ministry of Agriculture and Agrarian Reform (p. 31). The performance and activities of the company who was responsible for management had been supervised by the Libyan Land Reclamation Authority. The lack of engineering experience in that authority constrained the government to ask WAKUTI to support the LRA to supervise the company activities as there was no Libyan management capable of supervising the contract company's activities.

3. <u>Second - Stage 2</u>:- As Stage 1 was completed and Stage 2 started the need arose for an absolutely new type of management i.e. instead of construction and civil works management, agriculture reclamation management. However, the second phase - Stage 2 of the project was operated by a Libyan contractor who carried out leaching, reclamatory cultivation and other agricultural production processes.

This contractor is the GCMAP, under the supervision of the TPSC, who was responsible for management of the project. The contract started on 15 March 1974 and was supposed to be completed on 15 March 1977, [22] but as it did not perform according to schedule the contract became open-ended. The twenty agronomists (85% expatriate) of the GCMAP shown in Table No. 4.3.1 were appointed as follows:-

1 Manager project.

3 Following up committee, for supervising and organizing the agriculture processes

2 Supervisors for agricultural machinery

8 Supervisors, one supervisor for each area of the project except area East and area West where there are two supervisors appointed.

2 Laboratory supervisors for soil sampling and analysing.

2 Windbreak supervisors.

1 Surveyor supervisor.

1 Leaching supervisor.

Between 15 March 1975 and 14 March 1977 WAKUTI acted as consultants on behalf of the TPSC. The six agronomists (50% expatriate) of the TPSC shown in Table No. 4.3.2 are appointed as follows:-

1 Chairman of the committee.

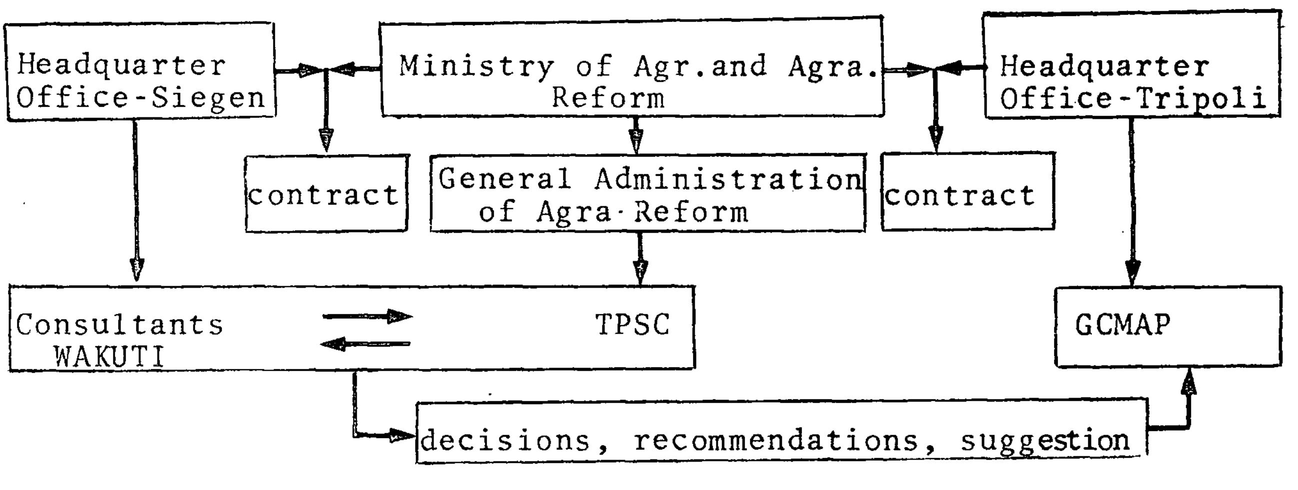
1 Vice Chairman.

1 Treasurer.

1 Laboratory supervisor to supervise the soil sampling and leaching carried out by GCMAP.

2 Supervisors for organizing and supervising the agriculture processes performed by the GCMAP.

All decisions, recommendations and suggestions taken by both WAKUTI team and the TPSC have to be passed to the GCMAP for execution. Figure No.4.4.1 below shows these consequences.



As may be seen from Figure 4.4.1 and from an examination of the various working reports,[23] the number of links within the communication network was very large and very little true management role could be exercised by any agency. It is not surprising that senior personnel i.e. the project manager and the 3 members of the follow up committee, changed very frequently.[24] Thus in September 1975 the project manager of the GCMAP left, but his successor only stayed until February 1976 when he was also replaced. In June 1976 when the performance of the company started to improve slowly after the unrest caused by the changes had been overcome the manager changed again. From that time to September 1976 the manager was frequently replaced. This ended when the manager in charge from February 1976 to June 1976 was re-established. Only then had the project time to recover and to develop properly. The situation for the post of the Chairman of the TPSC was just the same.[25]

In October 1975 the first Chairman left and his successor held the post until 1976. Following a period of uncertainty with frequent changes, in August 1976 a new chairman was chosen; however his employment only lasted till December 1976.

On December 20th, 1976 yet another chairman took office and the old system, i.e. that the committee controlled the company, was changed into a partnership management which is still operating with the same personnel.

4. After examining the cumbersome established management so far involved we have to examine the management requirements of the planned production phase.

The new management for central project services and control of the agricultural execution works, farm supplies, farm outputs and water distribution etc. would be carried out by the agriculture cooperative society, the management structure of which was designed as follows:- (26)

1. General assembly

   a) Approval of the expenditure of the agriculture cooperative society establishment.
   b) Layout - a plan for the agricultural cooperative society within the framework of the government plan.
   c) Election of the management committee.
   d) Layout of local ordnances.

The general assembly has to hold a meeting once a year at least to discuss the reports prepared by the committee of management e.g. review of the financial report, and approving the budget and new executive plan for the next year.

2. Committee of management. (27)

This committee is the executive committee for the a.c.s. It consists of 5 members at least and 11 members at most; as the first case is taken this will be as follows:-

One chairman
One Vice Chairman
One Treasurer
Two members

However the agriculture cooperative society reflects part of the Ministry of Agriculture and Agrarian Reform policy and it is the means of communication between the Ministry and the farmers. Thus the Ministry could encourage and sometimes dictate, through the agriculture cooperative society, choice of crops e.g. cereals such as wheat and barley. Furthermore, the Ministry through the society would buy any surplus quantities at prices which the Ministry would determine according to the quality of those commodities. This society would supply the farmers with inputs such as seeds, fertilizers, insecticides and equipment etc. at reduced prices i.e. sometimes 50% of the price of the cost to the government.[28] Additionally, the society would help them with their agricultural processes, e.g. ploughing, sowing and harvesting. Furthermore, the society would control the farmers commodities e.g. transporting, storing and marketing.

Based on other similar projects in Libya such as the Hadhba Khadra project, one can assume that the agriculture cooperative society would be dominant in the Tauorgan project even within the ideal of self sustained growth.

However, these planned structural elements tackled only the relation between settlers and the society as far as agricultural commodities and some physical inputs are concerned. Much more fundamental in the management relationship is the degree of independence given to the settlers in other areas of choice e.g., disposal of land, utilisation of land and water etc. In Chapter 2 we noted clauses of the provisions (pp.43-44) which arise here. A definite answer about whether division and sub-division of the new farms will or/will not take place can not be given because the Tauorga project area so far, to the end of 1977, has not yet been distributed to the settlers. Secondly, a period of 15 years has not yet elapsed because the relevant law (p.43) was issued in 1970, and thus a practical example of any other similar project can not be utilised as a precedent.

But the following discussion gives some guidance in answering this question. Theoretically the settlers are not independent because they are restricted by clause 6 of the provisions, through which the Ministry of Agriculture and Agrarian Reform can dictate its policy by its representative i.e. the agriculture cooperative society. Practically, the settlers' situation will always depend on the a.c.s. because unless the settlers are members of the a.c.s. they will not be entitled to have the benefit of the society's facilities. However, this control will be maintained as long as the a.c.s. management system is effective and there is no reason to suppose that this would be the case.

We can examine other similar projects, such as the Hadhba Khadra agriculture project, where each settler was allocated 6 ha. (29) and each holding was to be cultived as follows -(30) 2 ha. fruit, 2 ha. vegetables, 1.5 cereals and 0.5 forage. But in reality, in the summer of 1977, most of the settlers were cultivating the following - 2 ha. fruit, 1ha. vegetables and 1 ha. zea maize. In the Misurata development project (31) (pp. 244-246) each well in East Dafnia, with 36 farms, was projected, in regard to the water availability, to supply 3 Lt/sec. for irrigation purposes. Some of the farmers, in order to utilize more water than was designated, have spoilt irrigation installations by cutting the connection between the pump and irrigation system and by directing and accumulating the water in reservoirs which they constructed themselves. In this way they are using 5-6 Lt/sec. which has led to anarchistic utilization of water and has serious consequences on the life of aquifers in the project area.

On one hand these two examples show that in the absence of proper management by the agriculture cooperative society and/or the absence of a proper extension service, the settlers ignored government instructions. If the government is to ignore these initiative changes, and this appears to be what is happening, the settlers may start to change other components of the project including dividing the farms by inheritance.

On the other hand, one may assume that dividing and sub-division of the farms, may not take place because the Libyan government is very concerned to put a limit on that. Thus in 1975, the Ministry of Agriculture and Agrarian Reform issued law 46, [32] to overcome the problem of pigmy farms. This programme of reform was to encourage landholders to avoid simple sub-division by recommending that:-

1) Farmers should combine to set up a cooperative farm sharing the returns.

2) Farmers should lease land to adjacent farmers.

3) Farms should be sold at a reasonable price.

Indeed no definite answer can be given, even though the government may threaten the settlers by applying clause 7 of the same provisions should they start dividing the land. But clause 7 itself is not clear if it is valid for good or its validity will be over after the elapsing of the 15 years period in clause 5.

There is no evidence to suggest that Libya has the capability of providing the large number of management systems necessary if project control is to be effective and if project productivity is to be achieved.

CONCLUSION

Undoubtedly, the successful implementation of an agriculture plan in general depends on: First, it is a matter of proper management, which should be familiar with and experienced in the preparation of a plan of production which is logical and consistent with expectations of the conditions which will prevail not only at the present but also in the future. It involves taking key decisions about the level and combination of products to be produced, kinds and levels of inputs to be used and details of implementation. A management team must be capable of putting the production plan into action. It involves conducting production activities as planned and adjusting these according to the changing of the five key factors and the rest of the four main headings. Management must also have the flexibility to absorb designed feed-back, learning, obtaining information, monitoring, adjusting to unforeseen changes; all essential to the management knowledge, and all activities involved in the project. However, all this requires qualified experience and a stable team of personnel in management.

But in this project, as in many in L.D.C's, this was not the case. The experts in leading positions in the GCMAP and TPSC changed frequently and this was damaging since agriculture development is a long term undertaking field crop production, dependent on fairly time-inflexible biological processes; for instance one can only experience two complete processes per year i.e. two cropping patterns per year.

Therefore, so as to accumulate as much experience as possible it is of utmost importance that the same management team is employed in the project for at least two or three full production cycles. Secondly there is the need for appropriate organization and administration to give the possibility for progress based on available real financial resources and flexible utilisation of the five key factors. This greatly exceeds the organization and management capacity available.

Problems of rigidity in administrative systems such as those found in administrative systems of governments in almost all less developed countries (e.g. Libya), with mixed economies are anachronistic. Established long ago to meet conditions which differ greatly from those prevailing today, they have not been adapted sufficiently to greatly changed circumstances.(33)

Documents and files, as with management authority, have to be handled in strict procedural steps through administrative layers.(34)

Internal organizational and management efficiency must be matched with equal efficiency in other systems upstream and downstream. The total demand made on management expertise and organisational skills by any project extend well outside that project e.g. to public utilities, transport, customs handling at ports etc. To an L.D.C. therefore the strain on youthful management and administration systems is a multiplier of the direct requirement made by the project.

In spite of announcing an administrative revolution to lessen clerical work and legislation which are not necessary to fulfil the people's aims and those of the revolution current since 1970 in Libya, the required changes and flexibility, which would facilitate and ease the administrative processes, minimizing the routine etc. were not entirely attained.

In this chapter the factors of production involved in the project implementation under four main headings have been examined; their interaction and relationship to other described physical factors i.e. the five key factors examined in Chapter 3 is considered at the beginning of this chapter.

To some extent the range of choice offered by the five key factors can be extended by the application of the inputs classified under the main heading of capital, labour, human skill and management e.g. poor soil may be remedied by the application of fertilizer, poor natural drainage may be overcome by digging ditches, poor beef fattening performance on indifferent grazing ground by intensive rearing in controlled indoor environments. Similarly a shortage of capital will be less restrictive to the farmers' freedom of action in areas where the five key physical factors are favourable etc.

Greater restriction in one direction may be alleviated by greater freedom in another. Capital from the Libyan government and assistance through the cooperative organization are theoretically available in order to attempt to improve flexibility and thereby help to overcome the limiting five key factors. As we shall see in later chapters, the interdependence of all these input factors and the relative significance of individual factors and sets of factors now become the key questions, not only in evaluating the Tauorga project but in the examination of analogous development processes elsewhere.

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CHAPTER FIVE

DEVELOPMENT PROCESSES AND OBJECTIVES OF THE PROJECT

In Chapter Three the five key groups of physical factors were discussed in detail. In Chapter Four the four main groupings of economic, social and organizational factors were discussed. In the light of the foregoing this chapter comprises of two parts:

Part One - covers the development processes of the project e.g. first phase and second phase - stages 1 and 2, and particular attention will be paid to the second phase - stage 2.

Part Two - covers the project's objectives : the physical factors have consequential effects through the constraints and opportunities they afford and through the technical and organisational requirements necessary for the exploitation of physical resources. Conversely, the social, economic and organisational factors affect the evaluation of the resources, the reasons for their exploitation and the capability of producing a stable and profitable production resource exploitation system.

PART ONE

5-1 The Development Processes

5-1.1 First Phase

This was carried out between 1960-1970 by teams from three different countries and included: [1]

i) Analysing Tauorga springs' water.

ii) Measuring the rate of discharge of the springs.

iii) Analysing soil samples in a total area of 8,000 ha. and selecting the best 3,000 ha. gross area of the project.

iv) Design and planning of the project including the central village, irrigation and drainage systems, wind breaks and topographic survey.

5-1.2 Second Phase - Stage One

Construction Stage

In the light of the available findings of the study stage the Libyan Government decided to build the project. This stage was carried out by the Egyptian Boheira Company according to a contract signed on 8th August, 1970, under the supervision of WAKUTI KG from March 1972.

Construction was planned to take 2 years, starting in November 1970, however the actual execution period exceeded three years.[2] By the end of 1973 the following works had been carried out:-

1. Irrigation system [3] which included -

   a) main feeder canal; total length 2.600 km.

   b) main irrigation canal; total length 2.400 km.

   c) sub-1 irrigation canals; total length 20 km.

   d) sub-2 irrigation canals; total length 50 km.

   e) lateral irrigation canals- total length 156.5 km.

   f) structures in irrigation canals, i.e. covered section pipes, culverts, branches, outlets, weirs and bottom falls.

   g) pumping stations, distribution chambers and elevated reservoirs.

2. Drainage system[4]

a) field drains; total length 185 km.

b) lateral drains; total length 173 km.

c) sub-2 drains; total length 50 km.

d) sub-1 drains; total length 25 km.

e) main drainage canal; total length 12 km.

f) principal drains; total length 12 km.

3. Central Village [5]

The central village represents the administrative, social and cultural centre of the project and of the Tauorga region covering an area of approximately 60 ha. where the following elements were planned -

a) Dwelling Houses

(i) 300 houses for farmer settlers, each consisting of 4 rooms, kitchen, WC, bath, on the ground floor, 160 m^2 and open garden, 160 m^2.

(ii) 36 houses for employees consisting of 5 rooms, kitchen, WC, bath on the ground floor 120 m^2 and open garden, 270 m^2.

b) Official buildings -

(i) One school - total area 3,400 m^2.

(ii) One hospital including pharmacies and laboratories and staff accommodation, 400 m^2

(iii) One administration building to include a bank, post office and some 16 office suites, 1020 m^2 and further 16 office accommodation, with service facilities etc. All on the ground floor and first floor.

Total floor space : 2 x 510 m^2 = 1020 m^2

Total interior space : 2 x 1500 m^3 = 3000 m^3

(iv) One Central Market consisting of 10 sale-rooms with storage rooms and service rooms; total floor space 350 m^2.

(v) One police station - total floor space 820 m^2.

(vi) One resthouse with 10 guest rooms; total floor space 2 x 210 m^2 = 420 m^2.

(vii) One mosque; total floor space 300 m^2.

(viii) One service station, including 2 workshops, 15 garages etc. - total floor and yard area 1630 m^2.

(iv) One warehouse including 4 closed and 3 open storage rooms etc. - total floor space 1900 m^2 and total yard area 1800 m^2.

All these buildings are connected with the project central water supply system, sewerage system with a sewage treatment plant and electricity distribution system. Throughout the village an asphalt road network is provided of approximately 5 km. total length (6 m wide) with curbstones, sidewalks and road-lighting.

The irrigation area is served by roads with a metal surface which run parallel to main and subsidiary drainage canals.

4. Surveying Works [(6)]

A. The project area was joined up to the fixed triangulation points in the L.A.R.

B. Levelling

(i) Cleaning the site of grasses and bushes.

(ii) Levelling had been carried out over all the fields in the project.

(iii) Most of the project area had been deep cultivated by either ripping (60 -100 cm) or deep ploughing (about 40 cm) in order to break widespread hardpans under the surface before leaching.

5. Earth Works

a. Where the irrigation canal is not excavated earth embankments were built to carry elevated sections.

b. Earth embankment was executed around the springs in order to control the water i.e. direct the water into the main feeder canal.

6. Plantation of outer windbreaks [7]

a. 218,000 trees - eucalyptus and cassuarina.

b. 320,000 trees - thorny acacia.

c. 1,000,000 cuttings of tamarisk.

The first planning phase and the second phase - stage 1, construction, except for 200 of the farmers' houses, drinking water station, sewage treatment plant of the central village were completed and most of the project works handed over to the Libyan government by the end of 1973. However, although the construction of the buildings noted above was complete, the Libyan Government did not formally take over the central village because the water-supply and sewage systems were not wholly functioning. From this period until October 1976 the central village was utilised only as the administrative centre from which the General Company for Marketing and Agricultural Production (see Chapter 5-1.3) operated in the project area. On May/June 1976 H. Allam Company made the final touches to the central village.[8]

In September/October 1976 the central village was formally handed over to the Libyan government.[9] The first phase and second phase - stage 1 were critical parts of the project because the success of the second phase - stage 2 was dependent upon the soundness and accuracy of both survey and construction. Early in 1977 the Ministry of Housing undertook the responsibility of constructing the balance of 200 settlers houses as and when necessary.

By the end of the first phase, and second phase, stage 1 most of the basic physical infrastructure had been undertaken, i.e. the irrigation and drainage works, roads, and most buildings. In terms of the development of the land potential, all the area intended for cultivation had been mechanically cleared and levelled, and preliminary production could, theoretically be started in 1974.

5.1.3 Second Phase - Stage Two

This stage included -

- Land preparation.
    - Flooding and leaching.
    - Reclamatory cultivation.
    - Inner wind breaks.
- Modifications of phase two - stage 2 works.
- Maintenance of the project.
- The recruitment and basic training of Libyan workers for operations listed above.
- Handing over.
- Hypothetical and actual end of phase two.

Land preparation for the second phase - stage 2 was initiated by the Land Reclamation Authority of the Libyan government. However, this did not continue for long and in April 1974 this phase of work was undertaken by the General Company for Marketing and Agriculture Production.

The GCMAP was to carry out leaching and reclamatory cultivation on 2162.8 ha. utilising six successive cropping patterns in several Hoshas as well as improving the soil structure and exploiting those few Hoshas (120.6 ha) without salinity problems (see Table No. 3.6.1). The technical specifications for this work were laid out originally by the Ministry of Agriculture & Agrarian Reform and revised by WAKUTI Consulting Engineers, who were brought back to supervise the GCMAP activities and maintenance works of the project from March 1975 to March 1977.

Flooding and leaching [10]

The leaching operation specifications for removing salts from the plant root zone were strict i.e. the electrical conductivity value of the saturated soil extract was to be reduced to or below 8 mmhos/cm before land could be included in the reclamatory cultivation programme; if it was not, another 5 leaching processes had to be carried out and after that E.C. must be measured again. This work required:

1) Machinery Services

a. preparation for leaching and top soil according to the site conditions including sub-soil ploughing to a depth of 15 to 20 cm, the type of machinery used being determined according to site conditions. The soil then has to be planed by Eversman land plane so that the land is level after ploughing, then the soil must be loosened by cultivation.

b. preparation of embankments according to the site and soil conditions which must be able to tolerate water 15 cm deep. The embankments must be parallel to the irrigation canals, the strips must be about 8-10 m. long according to the field slope.

c. these processes have to be repeated every time; the area has been subjected to 5 leachings to facilitate soil aeration and to accelerate the leaching operation process.

2) Leaching [11]

a. when the E.C. value of the saturated extract is brought below 8 mmhos/cm then this area must be introduced into the cultivation programme. In the event of leaching operations being finished during times which do not correspond with the seeding periods the area must be irrigated in order to keep the soil moist.

b. if the E.C. values of the saturated extract remain above 8 mmhos/cm another 5 leaching processes must be carried out. After that the E.C. must be measured again.

3) Soil Study [12]

a) Sampling

Samples must be taken from each Djosa in order to check the E.C. value. The samples must be taken by auger, i.e. four samples from each corner of the Djosa and the fifth from the middle. These samples must be mixed so as to have the representative samples for each Djosa. From these samples a mixed representative sample for each Kata is taken. For complete analysis, two samples must be analyzed -

1. The first sample represents the top soil.
2. The second sample represents the sub-soil up to a depth of 60 cm.

b) Sample analysis [13]

1. After the first 5 leaching operation the E.C. value and pH must be checked in the saturated extract.

2. The complete analysis for the top soil must be carried out once a year when requested. This analysis includes the soluble cations (Ca, Mg, Na, K), soluble anions ($CaCo_3$, HCO_3, Cl, SO_4) and P, Na, K and any other analysis requested.

3. If the E.C. value is above 8 mmhos/cm in the saturated extract from the sub-soil layer additional 5 leaching processes must be carried out and the operations mentioned under 1 and 2 must be repeated.

4. Payment for soil analysis will be according to the table unit invoice, all results and the collected samples are ministerial property and if requested the analyses must be repeated and others must be carried out.

This part of planned land preparation has been described in some detail in order to emphasise the considerable demands on labour, skill and time made by land reclamation in this and similar environmental conditions.

<u>Actual land preparation</u>

Leaching operations had been started early in 1974 by the Land Reclamation Authority of the Libyan government; on March 1974 the GCMAP took over this responsibility and from early 1974 to April 1977 leaching operations were carried out. In January 1977 soil condition monitoring was performed over all the project area.

<u>Sampling</u> (14)

Samples were taken by auger from the surface layer of all Djosas in such a way that the soil from five borings would be mixed together to make one composite sample.

Analysis

(i) Chemical analyses

a. all samples were analysed for soil reaction (pH), electrical conductivity (E.C.), the result of these analyses are shown in Appendix - B1.

b. one sample per Kata was analysed for cations (Na, K, Ca, Mg), Anions (Cl, HCO_3, SO_4), $CaSO_3$, $CaSO_4$ and organic matter. The results of these analyses are shown in Appendix-B1 and B2.

(ii) Mechanical analyses

One sample per Hosha was investigated for water capacity, infiltration rate, pore volume, and water-soluble boron and texture. The result of these analyses are shown in Appendix-B3 and B1. Here again, the range of requirements for the scientific evaluation of soil conditions, as laid down in the revised specifications, illustrates the care necessary in land reclamation under these ecological conditions; also the requirement for qualified personnel to translate the results of the above mentioned analyses into practical measures to be applied on site.

Reclamatory cultivation[15]

Reclamatory cultivation was supposed to be directly connected with the results of leaching i.e. if the E.C. value of the field is below 8 mmhos/cm then it is introduced to reclamatory cultivation.

Reclamatory cultivation was to be carried out for six consecutive cropping patterns in order to improve the soil structure. During those cropping patterns tests would be carried out to find out the most suitable crops which would give suitable economic returns under specific soil conditions. The cultivation process or technical specifications were as follows -

A - <u>Preparation of soil for cultivation</u> -

1. Removal of embankments within the fields (Djosas) by cultivator or grader.

2. Ploughing under of the previous crop by means of 3-disc or 7-disc, 32-disc harrow or by rotavator according to the soil conditions.

3. Removal of stones from the field if necessary.

4. Land planing by means of Eversman land planes.

5. Loosening of the soil by means of cultivator.

6. The fields (Djosas)require a preliminary division into basin strips of 6-10 m. width by embankments, the height of the embankments to be determined by the conditions on site but normally 25 to 30 cm.

7. Pre-irrigation - The fields must be irrigated before planting in order to have sufficient moisture for germination.

8. Removal of basin embankments - see A.1.

9. Fertilization - chemical fertilizer must be broad-casted by means of fertilizer spreaders.

10. Harrowing - by means of harrow i.e. normal harrow and spring tooth harrows.

11. Seeding - to be carried out by seed drills. For the different crops, seeding time, distance and depth are shown in Table Nos. 5-1.3.1 and 5-1.3.2. All seed requirements must be covered by certified seeds.

(Note:- The processes mentioned under 8,9, 10 and 11 must be carried out during one day in order to keep the soil moisture for germination.

12. After processes 7 to 11 have been carried out the basin and field embankments will have been destroyed. Therefore, the fields must be redivided into strips according to the same specifications as in 6 above.

13. Irrigation - this must be carried out according to the demand of the plants. Uneven distribution of water i.e. excess surface water and areas without water must be avoided. The first irrigation must not be applied before sprouting. The number of irrigations is determined by the plant requirement.

14. Plant protection - it has to be ensured that an adequate plant protection service is established.

15. Harvesting - for cereals, harvesting combines must be used. For forage crops, such as alfalfa and Trifolium alexandrinum the harvesting process must be mechanised. The hay must be baled and properly stored.

B. Soil Analysis

For each season the E.C. value of all fields must be known. Therefore, the company must take samples and carry out analyses according to schedule.

C. Crop ownership

All crops in this pre-production phase were the property of the Ministry of Agriculture & Agrarian Reform.

D. Plant analysis

1. Samples must be collected from each Hosha during the vegetative period; the samples should be taken from the plant material above the surface.

2. Analyses for N,P,S,K, Ca, Mg and B must be carried out.

3. Other elements must be analyzed if requested.

E. Cropping

A cropping pattern must be established for each season according to soil condition, climatic conditions, availability of seeds and previous crops; Table 5-1.3.3 indicates the recommended cropping patterns for the project. This very clearly illustrates how both the need to continue experimentation and the spatial variations in soil conditions produced a complicated variety of cropping patterns which, in turn, made heavy demands on physical inputs and management and scientific skills. Tables 5-1.3.1 and 5-1.3.2 further illustrate how, under climatic conditions which strictly limit sowing periods, and given different space and depth requirements for crops, periodically heavy demands for a considerable range of mechanical implements and technical understanding by the cultivators follow from the need to experiment with a wide crop range. Table 5-1.3.4 illustrates the same point with reference to crop fertiliser requirements. In Table 5-1.3.5 the range and number of implements specified give an impression of the high capital costs involved and the consequence of using insufficiently trained and skilled operators and mechanics.

Table No. 5-1.3.1 Crops and Sowing Dates

Season	Crop	Date of planting seeds	Date of last planting	Remarks
Permanent	Alfalfa	15 Sep.	15 Oct.	
		15 Mar.	15 Apr.	Reseeding of gaps
Winter	Trifolium alexandrium	15 Sep.	31 Oct.	
	Barley	15 Oct.	1 Dec.	
	Oats	15 Oct.	1 Dec.	
	Fenugreek	15 Oct.	15 Nov.	
Summer	Sorghum	1 Apr.	15 June	
	Millet	1 Apr.	15 June	
	Cow peas	1 Apr.	30 Apr.	
	Sunflower	15 Mar.	15 Apr.	
	Maize	1 Apr.	30 Apr.	
	Sudan grass	1 Apr.	30 Apr.	
	Soya beans	1 Apr.	30 Apr.	

Source : Libyan Ministry of Agriculture and Agrarian Reform Revised Technical Specifications (Tripoli, 1976), p.12.

Table No. 5-1.3.2 Distance and Depth of Seeding of suggested crops

Crop	Distance between rows - cm	Depth of seeding cm
Alfalfa	15 - 22	1 - 2
Trifolium alexandrium	8 - 18	0.5 - 2
Barley	15 - 25	2 - 4
Fenugreek	15 - 17.5	5
Sorghum	15 - 17.5	5
Millet	15 - 17.5	5
Cow peas	20 - 30	2 - 5
Sudan grass	40	2 - 4
Oats	50	4 - 8
Soya beans	35 - 40	2 - 4
Maize	40	2 - 4
Sunflower	50	2.5 - 5

Source : Libyan Ministry of Agriculture and Agrarian Reform. Revised Technical Specifications (Tripoli, 1976), p.13.

Table No. 5-1.3.3 Recommended Cropping Patterns - Reclamation from Winter Season 1975/76 to Summer Season 1977

Hosha	Winter season 1975	Summer season 1976	Winter season 1976/77	Summer season 1977
1	Barley	Oats	Trifolium Alexandrinum	Catch crop*
2	Barley	Barley	Trifolium Alexandrinum	Katas 1-7 catch crops Katas 8-12 cowpeas
3	Rape	Oats/Alfalfa Kata 9 leaching	Rape	Alfalfa/Catch crop Kata 9 Millet
4	Rape	Oats/Alfalfa Kata 9 leaching	Rape	Alfalfa/Catch crop Kata 9 Millet
5	Trifolium Alexandrinum	Sorghum	Serradella	Catch crop Katas 8-10 Sunflower
6	Trifolium Alexandrinum	Sorghum	Vetch	Catch crop
7	Lupins (Lupinus angustifolius)	Oats	Sainfoin	Sorghum Katas 1/1+2,2/1+2,3/1+3, 4/1+4, 5/1+3 leaching
8	Trifolium Alexandrinum	Sorghum	Mustard	Catch crop
9	Trifolium Alexandrinum	Alfalfa	Alfalfa	Alfalfa Kata 8 Catch crop
10	Oats	Oats	Lupins	Catch crop
11	Oats	Oats	Lupins	Catch crop
12	Alfalfa	Sunflower	Wheat	Sunflower

Table No. 5-1.3.3. (Cont.)

Hosha No.	Winter season 1975/76	Summer season 1976	Winter season 1976/77	Summer season 1977
13	Alfalfa	Sunflower	Wheat	Sunflower
14	Alfalfa	Sunflower	Wheat	Sunflower
15	Oats	Alfalfa	Alfalfa	Alfalfa
16	Wheat	Soybeans	Alfalfa	Alfalfa
17	Wheat	Alfalfa	Alfalfa	Alfalfa
18	Fenugreek	Leaching	Bokhava clover	Katas 1-3+14-16+17-24 Catch crop Katas 4-13+25-26 Millet
19	Fenugreek	Leaching	Bokhava clover	Catch crop Katas 4-6 Millet
20	Fenugreek	Leaching	Leaching	Katas 5-14+19-27 Catch crop Katas 1-4+15-18 Millet
21	Barley	Leaching	Leaching	Katas 1-5+16-19 Catch crop Katas 6-15+20-24 Millet
22	Barley	Barley	Leaching	Katas 1-2 Catch crop Millet
23	Barley	Barley	Leaching	Katas 1-2 Catch crop Katas 3-8 Sorghum
24	Barley	Sudangrass/Leaching	Broad beans	Alfalfa/Sorghum

Table No. 5-1.3.3. (Cont.)

Mosha No.	Winter season 1975/76	Summer season 1976	Winter season 1976/77	Summer season 1977
25	Alfalfa/Sainfoin	Barley/Sudangrass	Buckwheat/Alfalfa	Alfalfa/Sudangrass
26	Alfalfa	Maize	Alfalfa	Maize
27	Alfalfa	Maize	Alfalfa	Maize
28	Alfalfa	Maize	Alfalfa	Maize
29	Rape	Barley	Fenugreek	Leaching
30	Rape	Barley	Fenugreek	Catch crop
31	Trifolium Alexandrinum	Barley/Leaching	Alfalfa	Catch crop Katas 7+12 Alfalfa
32	Trifolium Alexandrinum	Barley/Leaching	Alfalfa	Katas 1-5+10+12-16 Catch crop Katas 6-9+11 Alfalfa

* Catch crops are: Millet, Sorghum, Sunflower, Sesame etc.

Source: WAKUTI, Final Report (Siegen, 1977), pp.68-70

Table No. 5-1.3.4. Requirement of Nutrient

Crop	Nutrient in kg/ha.		
	N	P_2O5	K_2O
Alfalfa	50	90	160
Trifolium alexandrium	50	100	200
Barley	60 - 80	60 - 120	120 - 160
Fenugreek	50	100	200
Sorghum	100	40	50
Millet	100	40	50
Cow peas	40	50	100
Sudan grass	100	120	200
Oats	70 - 90	60 - 120	100 - 160
Soya beans	10 - 20	35 - 60	60 - 100
Maize	150 - 200	120 - 150	200 - 280
Sunflower	50 - 70	30 - 40	80 - 120

Source : Libyan Ministry of Agriculture and Agrarian Reform
Revised Technical Specification.
(Tripoli, 1976), p.15.

Table 5-1.3.5 Implements, early 1977

Total Number	Type of machine	Ready for work	In need of repair	Unrepair-able
68	Tractors	53	11	4
51	Mowers	24	16	11
22	Side delivery rakes	11	5	6
33	Medium harrows	31	1	1
16	Cultivators	14	2	-
11	Spring harrows	11	-	-
4	Landplanes	3	1	-
22	Seed drills	16	1	5
4	3-disc-ploughs	3	1	-
28	7-disc-ploughs	27	-	1
15	32-disc-harrows	12	3	-
30	Rotavators	18	9	3
11	Balers	7	4	-
2	Rear mounted angle dozer	2	-	-
2	Earth scoops	2	-	-
16	Fertilizer spreaders	5	4	7
5	Atomizers	5	-	-
13	Trailers	9	4	-
18	Motor pumps	14	3	1
7	Combines	6	-	1
378		273	65	40

Source: WAKUTI, Final Report (Siegen, 1977), p.113

The consecutive cropping pattern shown in table 5-1.3.3 should have been carried out during 1974-1977; some areas were cultivated with productive crops while the rest were cultivated with crops to be ploughed under as green manure for improving the soil. However, the cropping patterns (Table No. 5-1.3.6) which were actually executed, varied from those recommended (Table 5-1.3.3) due to various reasons, e.g. delay of arrival of imported fertilizers and delay in cultivation due to slow and low standard of work performance or ad hoc changes made by local management from time to time.

Inner wind-breaks (16)

Outer wind-breaks were planted during the first phase (see P. 124) but the necessity of planting inner wind breaks also was recognised in the early designs. Inner wind-break plantations during phase two - stage 2 at the same time as leaching and land reclamation was to be executed according to the following summarised technical specification.

1. Varieties

Casuarina and tamarisk were to be planted because they could tolerate the climate and soil conditions of the area.

2. Specifications of seedlings and cuttings

a. Casuarina seedlings should be 1.00 to 1.20 m. in size and 1 to 1.5 years old with good, healthy top growth.

b. Tamarisk, cuttings should be 25-30 cm long. The cuttings should be made just beneath a bud.

3. Where a marl layer is found beneath the top soil this should be broken up before planting in order to facilitate root penetration.

Table 5-1.3.6 Actual Cropping Patterns - Reclamation from Summer Season 1974 to Winter Season 1976/77

Hosha No.	Summer season 1974	Winter season 1974/75	Summer season 1975	Winter season 1975/76	Summer season 1976	Winter season 1976/77
1	Pearl Millet	Fenugreek	Cowpeas	Oats	Fallow	Barley
2	Pearl Millet	Fenugreek	Cowpeas	Barley	Katas 1-7 Pearl Millet	Katas 1-7 Oats Katas 8-17 Leaching
3	Katas 6-9 Barley	Alfalfa	Alfalfa	Alfalfa Oats	Fallow Alfalfa	Alfalfa/Kata 9 Barley Leaching
4	Katas 6-9 Barley	Alfalfa	Alfalfa	Alfalfa Oats	Fallow Alfalfa	Alfalfa/Kata 9 Barley Leaching
5	Katas 5-10 Cowpeas	Fenugreek Beans	Pearl Millet	Trifolium Alexandrinum	Kata 1-7 Pearl Millet	Barley Katas 8-9 Leaching
6	Cowpeas	Fenugreek Beans	Pearl Millet	Trifolium Alexandrinum	Pearl Millet	Oats
7	Cowpeas	Trifolium Alexandrinum	Pearl Millet	Trifolium Alexandrinum	Fallow	Vetch
8	-	Katas 8-19 Barley	Pearl Millet Barley	Trifolium Alexandrinum	Sorghum	Barley
9	-	Katas 5-8 Barley	Pearl Millet Barley	Trifolium Alexandrinum	Alfalfa	Alfalfa Kata 8 Barley
10	-	Katas 5-8 Trifolium Alexandrinum	Cowpeas	Oats	Fallow	Barley

Table 5-1.3.6 (Cont.)

Hosha No.	Summer season 1974	Winter season 1974/75	Summer season 1975	Winter season 1975/76	Summer season 1976	Winter season 1976/77
11	-	Katas 5-8 Trifolium Alexandrinum	Cowpeas	Oats	Fallow	Barley
12	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Maize	Wheat
13	Katas 4-7 Alfalfa	Alfalfa	Alfalfa	Alfalfa	Maize	Wheat
14	Katas 8-11 Alfalfa	Katas 6-11 Alfalfa	Katas 6-11 Alfalfa	Katas 6-11 Alfalfa	Maize	Wheat
15	Katas 1-11 Wheat	Fenugreek	Alfalfa Vegetables	Alfalfa	Alfalfa	Alfalfa
16	Wheat	Fenugreek	Alfalfa	Alfalfa	Alfalfa	Alfalfa
17	Wheat	Fenugreek	Alfalfa	Alfalfa	Alfalfa	Alfalfa
18	-	Katas 9-13+23-26 Barley (Green manure)	Katas 8-13+17-26 Pearl Millet	Fenugreek Barley/Fenugreek	Katas 14-17 Pearl Millet Katas 18-21 Sorghum	Katas 1-3+14-16 Oats Katas 17-24 Barley Katas 4-13+25-26 Leaching
19	-	Katas 8-15 Barley (Green manure)	Katas 8-15 Pearl Millet	Fenugreek BarleyFenugreek	Katas 7-10 Sorghum Katas 11-15 Pearl Millet	Oats Katas 4-6 Leaching
20	-	Katas 6-11+20-27 Barley (Green manure)	Katas 6-11+20-27 Pearl Millet	Fenugreek Barley/Fenugreek	Katas 8-9+22-23 Sorghum Katas 10-11+24-27 Pearl Millet	Katas 12-14 Oats Katas 1-4+15-18 Leaching Katas 5-11+19-27 Barley

Table 5-1.3.6 (Cont.)

Hosha No.	Summer season 1974	Winter season 1974/75	Summer season 1975	Winter season 1975/76	Summer season 1976	Winter season 1976/77
21	-	Katas 7-15+20-24 Barley (Green manure)	Katas 7-15+20-24 Cowpeas	Fenugreek Barley/Fenugreek	Katas 16-19 Sorghum	Katas 1-5 Oats Katas 16-19 Barley Katas 6-15+20-24 Leaching
22	-	Katas 3-10 Barley (Green manure	Cowpeas	Barley	Fallow	Katas 1-2 Barley Leaching
23	-	Katas 4-8 Barley (Green manure)	Katas 5-8 Cowpeas	Barley	Fallow	Katas 1-2 Barley Katas 3-4 Leaching Katas 5-8 Rape
24	-	Katas 4-8 Alfalfa - Barley	Katas 5-8 Alfalfa	Katas 1-4 Leaching Katas 5-8 Alfalfa	Katas 1-2 Sorghum Katas 5-8 Alfalfa	Alfalfa Rape
25	-	Katas 4-7 Alfalfa	Katas 1-3 Cowpeas Katas 4-7 Pearl Millet	Katas 1-3 Barley Katas 4-7 Alfalfa	Katas 1-3 Fallow Katas 4-7 Alfalfa	Alfalfa/Lupins Buckwheat Mustard Sainfoin
26	Alfalfa Pearl Millet	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Katas 1-3 Lupins Alfalfa
27	Alfalfa Pearl Millet	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Lupins Alfalfa
28	Alfalfa Pear- Millet	Alfalfa	Alfalfa	Alfalfa	Katas 12-13 Vegetables Alfalfa	Kata 12 Alfalfa Mustard Kata 13 Buckwheat Kata 14 Sainfoin

Table 5-1.3.6 (Cont)

Hosha No.	Summer season 1974	Winter season 1974/75	Summer season 1975	Winter season 1975/66	Summer season 1966	Winter season 1976/77
29	Cowpeas Pearl Millet	Alfalfa	Alfalfa	Barley	Fallow	Rape
30	Cowpeas	Alfalfa	Alfalfa	Barley	Pearl Millet	Oats
31	Cowpeas Pearl Millet	Fenugreek	Sorghum	Trifolium Alexandrium	Katas 1-2 Sudangrass Katas 7-12 Alfalfa Katas 3-6+8-11 Pearl Millet	Katas 7+12 Alfalfa
32	Cowpeas Pearl Millet	Fenugreek Barley	Pearl Millet	Trifolium	Katas 1-5+12-16 Sudangrass Katas 6-9 Alfalfa Katas 10-11 Fallow	Katas 1-5 Barley Katas 6-9 Alfalfa Katas 10+12-16 Oats

Sources: WAKUTI, Final Report
(Siegen, 1977), pp.71-74

4. Planting distance

The planting distance of casuarina should be 2m x 3m between trees and rows respectively, the planting hole dimension to be 50 x 50 x 50 cm. Tamarisk cuttings should be planted on all 4 sides of each farm at a distance between cuttings of 20 cm.

5. Disinfectants and activators must be used for the cuttings.

6. Irrigation

Furrows have to be irrigated to 'fix' the soil and to remove the salts, and planting should then be followed by irrigation immediately.

7. Replanting of gaps must be considered one month after planting.

8. Final handing over -

a. Casuarina

1. The row is considered satisfactory when healthy trees represent 90% of the total.

2. None of the gaps should be more than 6 m long.

b. Tamarisk

1. 80% of the cuttings must be successful.

2. The gaps should not exceed 40 cm per metre.

Modifications of Phase Two - Stage Two

In practice, and mainly arising from greater knowledge gained of pedological and ecological conditions during implementation, various modifications had to be introduced to the original proposals:

A - Flooding and Leaching

1) Machinery Services

Deep ploughing was originally specified to a depth of 90 cm. but shallower ploughing had to be adopted to avoid the creation of development of sink-holes.

2) Leaching

In the original version E.C. values of over 8 mmhos/cm were regarded as acceptable. However, since E.C. values of over 8 mmHos would not allow the growth of many of the most valuable plants it was recommended accepting only soil areas with E.C.'s below 8 mmhos.

3) Soil Study

A different sampling technique to give more reliable values was introduced, samples now being taken from each 1.35 ha. instead of 5 ha.

Sample Analysis - The E.C. values will now be measured after 5 leaching processes instead of 10. This proved to be a more realistic approach. Only E.C. values below 8 mmhos will now be regarded as satisfactory.

Soil Analysis - E.C. values of all fields must now be supplied each season.

B - Reclamatory cultivation

The different processes were brought into correct order and the timing factor added. Thus, working with the modification specifications based on changing field conditions was then possible

The crops recommended in the original specifications were not the best for improving the soil. The revised specification introduced new crops based mainly on the previous crop, E.C. value and availability of seeds. For example graminaceous crops should be followed by legumes.

The maximum salinity, as measured by electrical conductivity of 8 mmhos/cm, for fields to be cropped was adopted in a rather general way. Between 4 and 8 mmhos salinity levels are in fact high in respect of many plant tolerances and more attention should have been paid to spatial variations in salinity below the maximum permitted level.

Maintenance of the project [17]

In order to maintain proper functioning of the Tauorga Agrarian Reform project permanent repair and maintenance of the irrigation and drainage system, central village, sink-holes and weed control is required. The necessary works have to be carried out by the Tauorga project supervision committee (TPSC) by three different teams. Those teams, their jobs are listed below:-

Team for civil work

Execution of concrete work on all irrigation canals, reservoirs, structures, central village etc.

Team for earth work

Execution of all maintenance and repair work for drainage ditches, refill of sink-holes and repair of damage caused by erosion.

Team for joint sealing

This team has to execute the following works in the entire project annually -

a. cleaning all irrigation canals and reservoirs.

b. checking and repairing all joint sealing.

Recruitment and basic training to undertake the above operations was as follows : Libyan workers who were expected to become settler farmers in the plan were obliged to attend programmes of education and training.

The planned training programmes for the settlers which was supposed to be started in April 1974, included the following - land services; method of cultivation; fertilizing; pruning; grafting; weed control; plant protection from parasites, diseases and insects etc.,driving tractors and operating the agricultural machinery; removing their illiteracy; increasing their cultural and consciousness. However, no part of the programme started before June, 1975 and since then very limited training has been started.

(1) At a meeting between the committee and consultants on 2nd June, 1975 training in spreading fertilizer was planned to start on 10th June, 1975. [18] From the 18 labourers who attended the course only two were able to spread fertilizer correctly. On 8th July, 1975 the progress of these men was considerable. Of 16 labourers who were tested 6 proved able to spread fertilizer correctly, 8 showed a promising performance and only 2 were unable to do the job properly.

(2) 3 drivers were trained in the field for driving and levelling by landplanes. [19]

(3) On 28 April 1976 the company brought in an expert for plant protection. [20] His first activity was to start a training programme for a selected group of labourers for working with the atomizer. This was attempted twice : the first time the atomizer nozzles were out of order and at the second attempt the settlers were only shown for one hour how the machines worked.

(4) On April 1975 a training programme for driving tractors was started. Fourteen labourers attended the course and by mid-June, 1976, 12 managed to drive tractors and consequently were appointed and brought into field works; while 2 failed

the course and were excluded.

(5) It was believed that the Egyptian and Tunisian labourers working in the project were good agricultural labourers, so they were dispersed among the Libyan labourers so that, hopefully, the Libyans could learn and gain experience.

Handing over

The handing over of the basic physical infrastructure took place from the Egyptian Boheira Company to the Libyan government. Although the central village was handed over to the Libyan government in September-October 1976, it had been utilized as the administrative centre for the GCMAP which was operating in the project, since April 1974; this utilization included offices, workshop, warehouse and 36 houses for employees. In October 1976 the basic elements of the central village were operating after being handed over to several Ministries as follows:

1) The 100 farmers' houses were to be handed over to 100 of candidate settlers who were working already as labourers in the project, and who started living in those houses. The question arose again at this point of how the settlers were to be selected.* It should have proceeded according to the conditions of the Law No. 123 of 1970 and its executive legislation requiring that each settler (21) -

1. must be a Libyan national
2. must be working in agriculture or working in the project
3. must be able to carry out the required agricultural processes
4. must not already have an adequate income
5. should not have any income resource except from agriculture.

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* a[illegible] [illegible]tion criteria [illegible]oted on pp.43 & 44.

6. should not already possess a farm which is in size equal to the farm which will be allocated. In the case of already possessing a farm smaller than the allocated holding, he may be allocated a portion of land to bring it up to standard size.

7. should be completely free to farm and should not be practising any other employment.

8. priority, among those who fulfil those conditions, will be given to lower income families. In the case of incomes being equal,priority will be given to the larger family with a choice of having a farm or other employment.

However, the above mentioned conditions were not in practice during the selection of the 100 candidate settlers, but preference was given, first, to those families whose members had been working in the project during the construction period; secondly, to those families whose size assures an adequate labour force; and finally those with an inadequate income.

We must also note that by 1978 the 100 candidate settlers were only allocated houses and did not have a separate land allocation. They were still paid as labourers in the project and the creation of individual farming enterprises did not occur.

2) The school was handed over to the Ministry of Education in Misurata, who supplied the teachers and the necessary equipment, e.g. books, desks etc. The school is now used for the children of the 100 families.

3) The hospital was handed over to the Ministry of Health - Misurata who supplied the staff and necessary equipment. The hospital is now operating, except for emergency cases which have to

be treated in Misurata; an ambulance is available for this purpose.

4) The Bank has not been established but the post office was handed over to the Ministry of Wire & Wireless communication, who supplied all the necessary equipment.

5) Central market - handed over to the Misurata provincial administration - essentially the municipality authority of Misurata. It is rented to local tradespeople and contains shops which sell vegetables and tinned food imported from Misurata, and a butcher.

6) Police station - handed over to the Misurata police authorities who supplied the staff and all necessary equipment.

7) Resthouse - utilized by the GCMAP since April 1974.

8) Mosque - handed over to Ministry of Wakfs, who supplied the necessary furniture.

9) Service station and warehouse were utilized by the GCMAP since 1974.

This essentially covers the handover of the central utilities and social services concentrated in the project village of Tauorga to the regional administration. The agricultural area, which is the production base for the new village, still remains in the control of the Project Committee and the Ministry of Agriculture.

Regarding the part of the project relating to development of land potential, the hand over of this was planned to take place from the GCMAP to the Tauorga project supervision committee (TPSC) by April 1977.

i) Reclaimed areas - The technical criteria recommended (by WAKUTI as consultants) for determining whether land had been reclaimed and was ready for handover were an E.C. assessment of 8 mmhos/cm, or lower, and the soil structure had been sufficiently improved in physical status. In accordance with the required classification, 120.6 ha needed soil structure improvement only and 2162.8 required leaching and soil structure improvement. Unfortunately, this hand over did not take place because this goal was not achieved for several reasons (see chapter 6).

ii) Crops produced are TPSC property and include (a) crops produced seasonally from the reclaimed areas, such as alfalfa, barley, wheat etc. and (b) by-products of the land reclamation stage such as barley straw, wheat straw, millet etc.

Hypothetical and Actual end of Phase Two : Summary statement

Phase Two-Stage 2 of the project development should have ended by November 1975 with the following achievements -

1. In terms of land development potential -

   a) the reclamation of the project area, reducing soil salinity in the root zone to an E.C. level to below 8 mmhos/cm, improving the soil physical status and generally achieving good physical land condition.

   b) distribution of the project land to the 300 settlers in holdings of about 10 ha. each family.

2. The farmers selected and well trained and educated to manage their farms.

However, the objectives actually achieved were as follows -

1) Out of the proposed 300 farmers' houses, only 100 were constructed and were given to 100 families.

2) In terms of land development potential -

   a) The following areas had been leached since Phase 2 - stage 2 as shown in Table No. 5-1.3.7.

Table No. 5-1.3.7

Year	Area leached ha.
1975	391
1976	372
1977	320
Total	1,083

Source: Libyan Secretariat of Agriculture; Achievements of the Revolution, (Tripoli, 1978), p.129

Only in three hoshas, with a combined area of 159.5 ha. Nos. 16, 17 and 28 was the E.C. value reduced below 8 mmhos/cm; on a further 437 ha. salinity was decreased from original level to a level of below 10 mmhos/cm.[22]

b) Stones were removed from most of the project area, except in hoshas Nos. 13 and 14 totalling 102.5 ha - and the soil's physical status only improved in some fields.

c) Windbreaks[23]

Outer - by 1977 all the proposed trees were established

Inner - by 1977, 90% of the proposed trees were cultivated.

d) Distribution of farms to the settlers did not take place yet, but postponed indefinitely.

e) True farmer settlers are still not identified and the 100 families who have been given houses are employed in the project as monthly wage labourers.

f) Even these potential settlers were not educated at all and very limited training was given (see pp.147-149).

PART TWO

5-2 Project's Objectives

The Libyan Government had taken a basic decision to establish new settlement and new agricultural production on reclaimed land. Thus, Government policy has created the following demands -

5-2.1 Agricultural production - this has been partly covered in Chapters 3,4 and 5-1 and will be examined further in later evaluation.

However, Government policy was not merely agriculture exploitation, but also, simultaneously, the development of the oasis inhabitants. Thus the following additional demands arise from these development objectives -

5-2.2 Market Demands (projected) i.e. the ways in which, through market mechanisms, the production (analysed under 5-2.1 above) is translated into income accruing to the project and the project's farmers.

5-2.3 Improving the socio-economic and cultural life in the area i.e. the demands made by general policy and are met by the income noted under 5-2.2 above and also by Government inputs in the provision of services and facilities, e.g. education, health services etc.

These demand factors have some particular characteristics:-

1) All but the market demand factors are created by government policy and government capital.

2) Market demand factors e.g. for products of the newly cultivated land, may be influenced by government e.g. through subsidies of production or sales prices or tariff on imports, etc.

In the case of Libya, the price of agricultural products first become set by global prices against which domestic agricultural products could not compete because of production inefficiencies and secondly, by the growing practice of subsidising the consumer and maintaining low food prices of all products, imported and domestic.

Government action gives consumer subsidies by artifically lowering prices of imported goods e.g. 0.05 L.D per kg. sugar and domestic products e.g. 0.30 L.D. per kg. olive oil. It also gives producer subsidies partly through cheap capital e.g. housing, farms, equipment, etc. and partly through specific assistance with access to market - cheap transport, subsidised fertilizers, seeds, insecticides etc.

All this has required the formation of a number of different types of agencies with direct government assistance in an attempt to promote agriculture production e.g. agriculture cooperative societies, the agriculture bank and the General Company for Production and Agriculture Marketing, etc.

At the same time, the demand factors direct from government i.e. raising agriculture production, living standards etc.,also depend on the presence or growth of some other demand factors in the local population e.g. a sufficient desire for the realities of higher living standards to provide motivation to strive for higher productivity, higher income etc. Without such motivation technical aspects of the project in isolation, while they may remain critical in specific ways, become of secondary importance.

5-2.2 <u>Market Demand and Supply</u> : <u>volumetric approach</u>

Here we consider the equation between planned and projected values of product production and markets.

The market is of course not a general hypothetical market, but is a composite of various market demands for specific commodities and these will be affected by price and income fluctuations etc. and by government policy. The supply of these commodities is itself not a fixed variable in that production will be governed by physical feasibilities, specific profitabilities and by the choice of planned cropping patterns which are judged to be appropriate to the new settlers capabilities and to providing suitable incomes to the settlers - this being one integral objective of the project.

The market in Tauorga Oasis deals with small quantities of some agricultural commodities, among others, suited to the low output and low income of the inhabitants; most of the food items are only slightly changed e.g. dates, from the form in which they are harvested from the farm plots. Of the three main crops in the traditional sector dates are produced in sufficient quantity to meet local demand, but barley and wheat give poor yields and production does not satisfy demand. This unsatisfied demand naturally will be concomitant with high price, particularly if there is no control on price and/or the supplying of this demand by imports.

Therefore, the new Tauorga project was created by the government, hopefully, as a potential and viable production unit, first supplying goods relevant to local and regional demand and, secondly capable of extending this potential to realize participation in increasing domestic or native agricultural production in Libya as a whole. The first aim, in fact, cannot be achieved in isolation from the second; this is obvious through identifying three consecutive stages of development. The first is self sufficiency where the producer is his own market and there are as many outlets for agricultural produce as there are producers. The second stage involves the existence and use of local markets and exchange facilities. The third and final stage comes with the intervention of large food-processing industries and institutional buyers with large scale economies which begin to dominate the agricultural markets.

Theoretically the first and second aims - local and national supply of demand - fit in with these stages Nos. 1 and 2, but in practice can not yet be assessed before determining the final total volume of production of the project. Only then can one ascertain whether the project will mainly produce commodities which can be substituted for imports into the Tauorga region - with all this implies - or can produce surpluses for other regions.

In order to establish the volumetric relationship between the planned production of the Tauorga project and market demands, let us first assume the following:

The new farm products will be consumed by the farmers and their families in the first place; surpluses will be for sale to supply local Tauorga consumption; any further surplus quantities will be for supplying external markets - primarily in Libya. This is stated at length in the Project Objectives.

Very little precise data is available for the measurement of volumes of present or projected supply and demand, but from a variety of sources we can estimate at least the order of magnitude of the production of crops (given the land use recommendations of GAUDRL - see Table 5-2.2.1) and also the order of magnitude of surpluses or deficits of the harvested products relative to (a) domestic and (b) local demand.

In the following pages a) estimated planned project production and b) an estimation of present Tauorga population potential demand for agricultural products based on average per capita consumption in Libya X population are shown.

After the preliminary years of leaching, reclamatory cultivation and ascertaining water supplies from Tauorga springs, a permanent cultivation plan to be applied on the project was recommended by the GAUDRL of Egypt. This plan is shown in Table No. 5-2.2.1.

From personal field knowledge the land use and cropping pattern being established does not conform to the plan. By the end of 1977 the decision of the Ministry of Agriculture and Agrarian Reform to plant not less than 500 has. of date palms was being implemented. [24] By the end of 1977 no other tree crops had been planted except that by early 1977 about 950 seedlings of figs and pomegranate were planted at the side of drainage No.7 to serve as wind breaks. [25]

In this chapter and in the section on income from 'off farm' sales therefore, estimates are made of the volume and value of production on the basis of the planned cropping pattern.

Estimated planned project production

Estimates of the production volume can only be based on certain assumptions of proportional areas devoted to particular crops, assumptions which logically follow from an analysis of the very general recommendations made by GAUDRL. In Table No. 5-2.2.2 the areas shown as devoted to individual crops are utilised as giving reasonable orders of magnitude of details of land use. Since no final implementation of the GAUDRL design was

Table No. 5-2.2.1 Recommended permanent cultivation Plan

20% of the project net area (2283.58 ha) = 456.716		20% of the project area	20% (456.716) ha		40% of the project area (913.432) ha	
Vegetables		Fodder	Grain		Fruit trees	
Summer	Winter	Alfalfa	Summer	Winter	20% (456.716) ha.	20% (456.716) ha.
Kiney beans phaseolus Watermelon Potatoes	Peas Onion Tomatoes Potatoes	Oats, v.beans (Mix-ture) Sorghum	Ground nut	Wheat Barley B.Beans	Almonds Olives Guava	Citrus Grapes Pome-granate

Source: Boheira Co. Ltd. Technical Report No.1 (Egypt, 1970), p.6.

Table No. 5-2.2.2 The areas devoted to individual crops

<table>
<tr><th>Crop</th><th>Area ha.</th><th>Crop</th><th>Area ha.</th></tr>
<tr><td>Kidney beans</td><td>114.179</td><td>Almond</td><td>152.238</td></tr>
<tr><td>Phaseolus</td><td>114.179</td><td>Olive</td><td>152.238</td></tr>
<tr><td>Watermelon</td><td>114.179</td><td>Guava</td><td>152.238</td></tr>
<tr><td>Potatoes (Summer)</td><td>114.179</td><td>Citrus</td><td>152.238</td></tr>
<tr><td>Potatoes (Winter)</td><td>114.179</td><td>Grapes</td><td>152.238</td></tr>
<tr><td>Onion, dry</td><td>114.179</td><td>Pomegranate</td><td>152.238</td></tr>
<tr><td>Tomatoes</td><td>114.179</td><td>Barley</td><td>152.238</td></tr>
<tr><td>Peas, green</td><td>114.179</td><td>Alfalfa</td><td>228.358</td></tr>
<tr><td>Groundnut</td><td>456.716</td><td>Oats</td><td rowspan="2">114.179</td></tr>
<tr><td>Wheat</td><td>152.238</td><td>v.beans</td></tr>
<tr><td>Broad beans, dry</td><td>152.238</td><td>Sorghum</td><td>114.179</td></tr>
</table>

carried out this is the nearest approximation on which we can base later estimates of input and output values.

The average yield quantities per ha. for the agricultural crops recommended in the plan can be estimated from three sources:-

1) Data from the project itself.
2) Data from adjacent experimental farm.
3) Data based on the average production of Libya.

While the first and second types of data are possible to apply directly with care, the third is impossible unless specific corrections are made for local conditions, of which water salinity is the most important. Thus, where the third criterion is applied a standard yield decrement has been considered,* according to Appendix-C which shows the expected decrease in production with regard to water salinity. Therefore, average yield quantities per ha. for the agricultural crops recommended in the plan can be estimated as shown in Table No. 5-2.2.3.

Based on the size of the areas devoted to individual crops and on the average yield quantities per ha., the quantities of products from the project area to be expected are shown in Table No. 5-2.2.4

Unfortunately, these hypothetical production levels as given in Table No. 5-2.2.4 are expected to be even less as one considers that the soil salinity even after land preparation is often more than 4.2 mmhos/cm particularly since the irrigation water salinity averages about 2900 ppm T.D.S. Furthermore, the rates of wastage in harvesting are considerable. According to the Ministry of Agriculture and Agrarian Reform this loss rate is estimated at some 15 per cent for wheat, barley, olives and

* Estimated average production for the Tauorga project = Average production in Libya - Standard yield decrements.

Table No. 5-2.2.3 Estimated average yield quantities

Crops	Average yield tonne/ha.	Crops	Average yield tonne/ha.
Kidney beans	2 (1)	Almond	1.95 (12)
Phaseolus	3.77 (2)	Olives	2.52 (13)
Water melon	1.50 (3)	Guava	6.5 (14)
Potatoes (Summer)	3.21 (4)	Citrus	6.65 (15)
Potatoes (Winter)	1.685 (5)	Grapes	1.95 (16)
Onion,dry	2.95 (6)	Pomegranate	5.65 (17)
Tomatoes	3 (7)	Barley	0.82 (18)
Peas, green	2.85 (8)	Alfalfa(hay)	15.953 (19)
Groundnut	2.09 (9)	Oat, Vetch mixture	6.83 (20)
Wheat	1.00 (10)	Sorghum	8.37 (21)
Broad beans, dry	0.668 (11)		

Note : Yields have been converted from the standards quoted in the source by the use of expected decrements due to salinity. (See Appendix- C)

Sources :-

(1) Libyan Ministry of Agriculture and Agrarian Reform, Vegetable Cultivation - Summary and Results (Tripoli, 1973), p.27.

(2) Ibid, p.26.

(3) WAKUTI, op.cit., (1977), p.78.

(4) Libyan Ministry of Agriculture and Agrarian Reform, Potatoe cultivation (Tripoli, 1976), p.5.

(5) *Ibid*, p.5.

(6) FAO, *Production Yearbook*, 1973 Vol.27, Room,(1974), p.158.

(7) WAKUTI, *op.cit*., (1977), p.78.

(8) FAO, *op.cit*., p.163

(9) *Ibid*, p.131

(10) WAKUTI, *op.cit*., (1977), p.78.

(11) FAO, *op.cit*., p.106.

(12) Libyan Ministry of Planning and Scientific Research, *Collection of Census* (Tripoli, 1974), p.186.

(13) *Ibid*, p.126.

(14) Shaheen, Tauorga, July,1979, Letters communication.

(15) Libyan Ministry of Planning and Scientific Research, *op.cit*., p.125.

(16) FAO, *op.cit*., p.167.

(17) Shaheen, A. Tauorga, July, 1979, Letters communication.

(18) WAKUTI, *op.cit*., (1977), p.78.

(19) Libyan GCMAP, *Office Calendar* (Tripoli, 1977)

(20) Libyan Ministry of Agriculture and Agrarian Reform, *Oats and Vetch Cultivation* (Tripoli,1976), p.6.

(21) China Republic, *Report of Field Experiments Conducted in Tauorga* (Tripoli, March 1967), p.9.

Table No. 5-2.2.4 Estimation of the expected agriculture production from the project area

Crop	Expected production from project Tonne	Crop	Expected production from project Tonne
Kidney beans	570.875	Almond	296.79
Phaseolus	430.439	Olive	383.544
Watermelon	171.262	Guava	989.30
Potatoes (Summer)	366.501	Citrus	1012.13
Potatoes (Winter)	192.384	Grapes	296.79
Onion, dry	336.816	Pomegranate	859.93
Tomatoes	342.525	Barley	124.804
Peas, green	325.398	Alfalfa	3642.995
Groundnut	954.536	Oats, v.beans mixture	3642.995
Wheat	152.20		
Broad beans, dry	101.669	Sorghum	955.678

dried dates.[26] Another aspect is that a significant proportion of certain crops such as onions and groundnuts are often left unharvested. [27] Losses in poorly designed storage systems are also high.

Securing and maintaining a realistic production level also assumes prices to the producer which will encourage production, and prices to the consumer which will encourage consumption of these particular products - this quite apart from measures of government intervention. In addition, as considered elsewhere in this thesis, there are all the other production requirements e.g. management and, of course, the objective of viably providing the settlers with levels of income which assure a reasonably high standard of living etc.

Estimation of agriculture commodities consumption

Before one can start estimating the surplus production from the project area, the quantities of agricultural products which will be consumed by the settlers must be considered. This will be based on an estimated average consumption per capita in Libya, unless otherwise indicated:

$$\frac{\text{Average total production of Libya for 3-5 years of 1970s}}{\text{Average total population of Libya for 3-5 years of 1970s*}}$$

Consideration has been given to use of storable and canned commodities as much as possible. Table No. 5-2.2.5 shows the estimated average consumption per capita in Libya.

As far as fodder is concerned there is no data available concerning livestock in the Tauorga region. We, therefore, have to assume, in the absence of contrary information, that all project fodder production will be surplus to local requirements and will be

* Efforts are made to apply the same years as those used for the average total production.

Table 5-2.2.5 Estimated average consumption per capita in Libya - kg[x]

Agricultural Commodity	Estimated average consumption per capita in Libya kg.	Agricultural Commodity	Estimated average consumption per capita in Libya kg.
Kidney beans*	1.366 (1)	Olives***	11.59 (12)
Phaseolus**	0.455 (2)	Guava+	1.48 (13)
Watermelon	11.063 (3)	Citrus++	6.795 (14)
Potatoes	4.466 (4)	Grapes+++	3.781 (15)
Onion, dry	10.100 (5)	Pomegranate++++	3.781 (16)
Tomatoes	5.179 (6)	Barley	-
Peas, green	0.455 (7)	Alfalfa	-
Ground nut	5.079 (8)	Oats	-
Wheat	15.73 (9)	v.beans	
Broad beans	1.366 (10)	Sorghum	-
Almond	1.015 (11)		

(x) For the average total population of Libya; Libyan Ministry of Planning; Population Census, (preliminary results) (Tripoli, 1973), p.9 is used.

* Estimated as broad beans

** " peas, green

*** Olive oil and pickled

\+ Estimated as figs

++ Orange, Tangerines and lemon

+++ Fresh and juice

++++ Estimated as grapes

Sources:

(1) FAO, op.cit., p.106.

(2) Ibid, p.161.

(3) Ibid, p.165.

(4) Libyan Ministry of Agriculture and Agrarian Reform, *Potatoe Cultivation* (Tripoli, 1976), pp.5-8.

(5) Libyan Ministry of Planning and Scientific Research, *Collection of Census* (Tripoli, 1974), p.134.

(6) *Ibid*, p.124.

(7) FAO, *op.cit*., p.161.

(8) Libyan Ministry of Planning and Scientific Research, *Collection of Census*, (Tripoli, 1974), p.124

(9) Libyan Ministry of Agriculture and Agrarian Reform, *op.cit*., (Tripoli, 1976b), pp.49-51; And Libyan Ministry of Planning and Scientific Research, *Collection of Census*, (Tripoli, 1974), p.123.

(10) FAO, *op.cit*., p.106.

(11) *Ibid*, p.186.

(12) Libyan Ministry of Agriculture and Agrarian Reform, *Olive Fly* (Tripoli, 1973), p.3.

(13) Libyan Ministry of Planning and Scientific Research *Collection of Census*, (Tripoli 1974), p.126.

(14) FAO, *op.cit*., pp.176-178; And Libyan Ministry of Planning and Scientific Research, *Collection of Census* (Tripoli, 1974), p.125.

(15) Libyan Ministry of Planning and Scientific Research, *Collection of Census* (Tripoli, 1974), p.128.

(16) *Loc.cit*.

marketed to other regions e.g. Tripoli.

After estimating the expected agricultural production from the project and the estimated per capita consumption, it becomes possible to know if those agricultural quantities can satisfy the demand of the future settlers or will be surplus which represent 'off-farm' surplus volume or whether there would be any deficit. This is shown in Table No. 5-2.2.6.

Those surplus volumes would be 'off-farm' sales and in the first place can supply the Tauorga region demand, but since apparently this volume would exceed the Tauorga region potential market consumption again there should be surplus quantities as shown in Table No. 5-2.2.7.

Since Tauorga region has long been supplied with agriculture commodities from Misurata, before the creation of the project, it is not wise to think of exporting the surplus quantities from Tauorga project to this city region which already has a surplus of many commodities. Not only is there the question of physically disposing of commodities in this way but the supply of additional surpluses would be likely to produce a problem of decreasing prices. On the contrary one must think rather of the future direction of flow of the original agricultural commodities channelled through Misurata to Tauorga which would now be replaced by the new project's production.

For this reason, although Misurata is the nearest city to Tauorga, the project's products are unlikely to be exported to it, but rather will have to find a market in Tripoli. Table No. 5-2.2.8 shows the agriculture commodities of off-farm sales, quantities to be exported to the Tauorga region and the quantities to be exported to Tripoli.

Table No.5-2.2.6 Surplus or deficit of the agriculture commodities

Agricultural Commodity	Expected production from the project area	Estimated quantities consumed by the 300 settlers' families (5.8 each).Tonne	Surplus or Deficit
Kidney beans	570.875	2.376	+ 568.499
Phaseolus	430.439	0.791	+ 429.648
Watermelon	171.262	19.249	+ 152.013
Potatoes	558.885	7.770	+ 551.115
Onion,dry	336.816	17.400	+ 319.416
Tomatoes,fresh	342.525	9.011	+ 333.514
Peas,green	325.398	0.791	+ 324.607
Ground nut	954.536	8.837	+ 945.699
Wheat	152.2	27.370	+ 124.83
Broad beans, dry	101.669	2.376	+ 99.293
Almond	296.79	1.766	+ 295.024
Olives	383.544	20.166	+ 363.378
Gawafa	989.3	2.575	+ 986.725
Citrus	1012.13	11.823	+1000.307
Grapes	296.79	6.578	+ 290.212
Pomegranate	859.93	6.578	+ 853.352
Barley	124.804	-	+ 124.804
Alfalfa	3642.995	-	+3642.995
Oats Vetch mixture	779.842	-	+ 779.842
Sorghum	955.678	-	+ 955.678

Table No. 5-2.2.7 Tauorga region potential market consumption

Agricultural Commodities	Estimated quantities expected to be consumed by Tauorga region excluding settlers Tonne	Production from existing Tauorga region farms (28) Tonne	Tauorga region potential market for projects additional production Tonne
Kidney beans	9.506		9.506
Phaseolus	3.166		3.166
Watermelon	76.976	5.0	71.976
Potatoes	31.074		31.074
Onion, dry	70.276		70.276
Tomatoes, fresh	36,035	0.6	35.435
Peas, green	3.166		3.166
Ground nut	35.341		35.341
Wheat	109.449	13.6	95.849
Broad beans, dry	9.505		9.505
Almond	7.062		7.062
Olive	80.643		80.643
Guava	10.298		10.298
Citrus	47.281		47.281
Grapes	26.308		26.308
Pomegranate	26.308		26.308
Barley	-		
Alfalfa	-		
Oats & Vetch	-		
Sorghum	-		

Table No. 5-2.2.8 Agriculture commodities of off-farm sales to Tauorga region and Tripoli market

Agricultural Commodities	Surplus quantities after satisfying settler's demand (off-farm sales) tonnes	Quantities exported to Tauorga region market tonnes	Quantities to be marketed to wider markets (Tripoli) tonnes
Kidney beans	568.499	9.506	558.993
Phaseolus	429.648	3.166	426.482
Watermelon	152.013	71.976	80.037
Potatoes	551.115	31.074	520.041
Onions, dry	319.416	70.276	249.14
Tomatoes, fresh	333.514	35.435	298.079
Peas, green	324.607	3.166	321.441
Groundnut	945.699	35.341	910.358
Wheat	124.83	95.841	28.989
Broad beans, dry	99.293	9.505	89.788
Almond	295.024	7.062	287.962
Olive	363.378	80.643	282.735
Gauva	986.725	10.298	976.427
Citrus	1000.307	47.281	953.026
Grapes	290.212	26.308	263.904
Pomegranate	853.352	26.308	827.044
Barley	-	-	124.804
Alfalfa	-	-	3642.995
Oats & Vetch	-	-	779.842
Sorghum	-	-	955.678
Total		563.186	12577.765

Fig. No. 5-2.2.1 represents the volume of agriculture commodities which will be consumed by the settlers, export to Tauorga region and export to Tripoli.

As noted earlier the figures for potential production and consumption are the best estimates which can be derived. Also, on the same basis the Tauorga region's potential market demand for products is the best estimate which can be made. It follows that assuming the planned levels of project production are achieved, since it is improbable that marketing mechanisms will operate in a simple fashion directing all off-farm surplus in the first place to the Tauorga market until that is saturated, the surpluses for sale outside the local region should be greater than those estimated.

Price Mechanism

The basic supply and demand situation determines the establishment of the price of any goods or services, given any significant marketing or purchasing freedom. The prices of agriculture commodities in Libya have been increasing particularly from 1970 onward as a result of increasing demand pressure emanating from increased family consumption and the growth of population and the number of Arab and foreign expatriates employed in various development projects. The local output of agricultural products did not develop at such a pace as to match the growing demand and reduce the shortage in domestic supply. In addition, the international prices of agricultural commodities were reflected in the level of local prices of food commodities. The fluctuations in the retail prices of various agricultural commodities reflect therefore a range of balances of forces as they affect different specific commodities, as illustrated in Figure No. 5-2.2.2.

Fig 5-2.2.1 The Volume of Planned Agricultural Production by Commodities

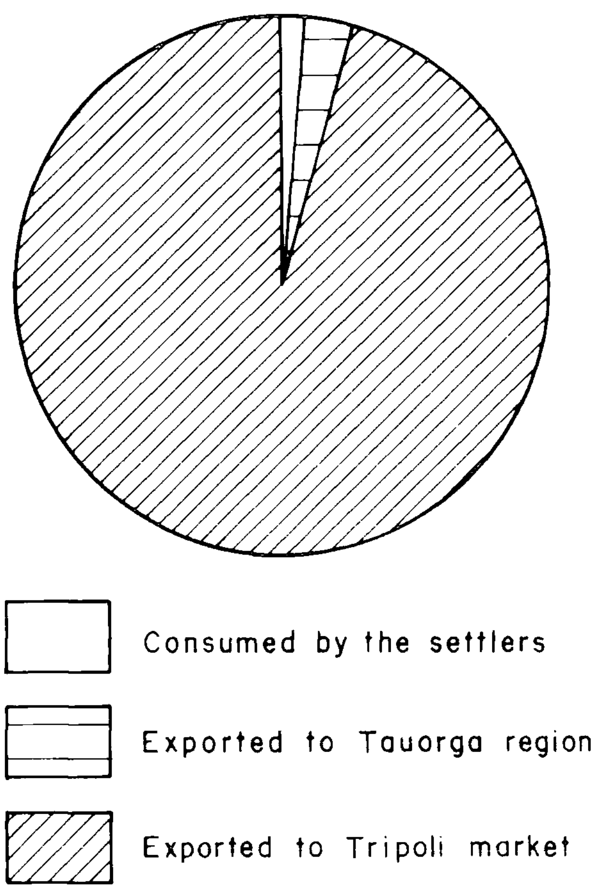
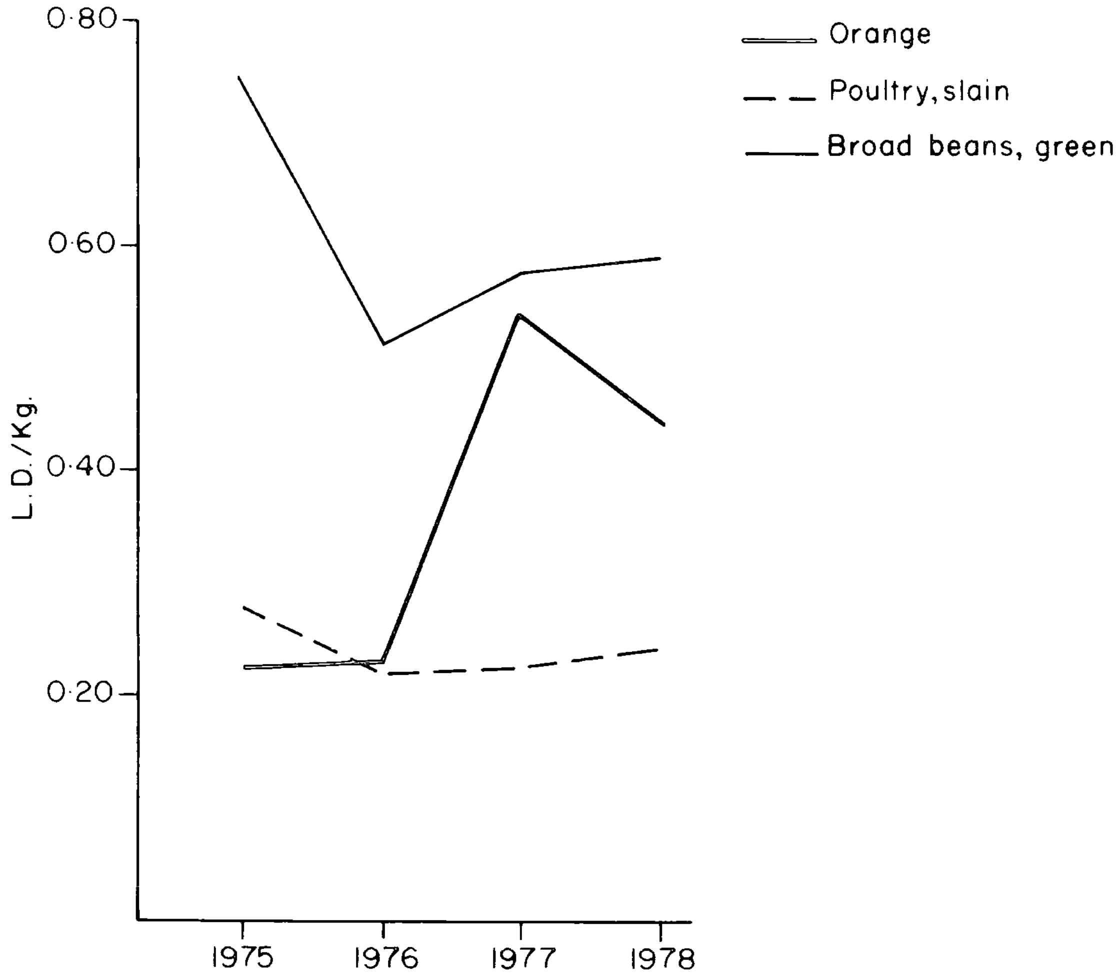


Fig. No. 5-2.2.2
Fluctuations in the retail prices



Source: Libyan Ministry of Planning, Quarterly retail prices in Tripoli City 1975-1980 pp. 2-4

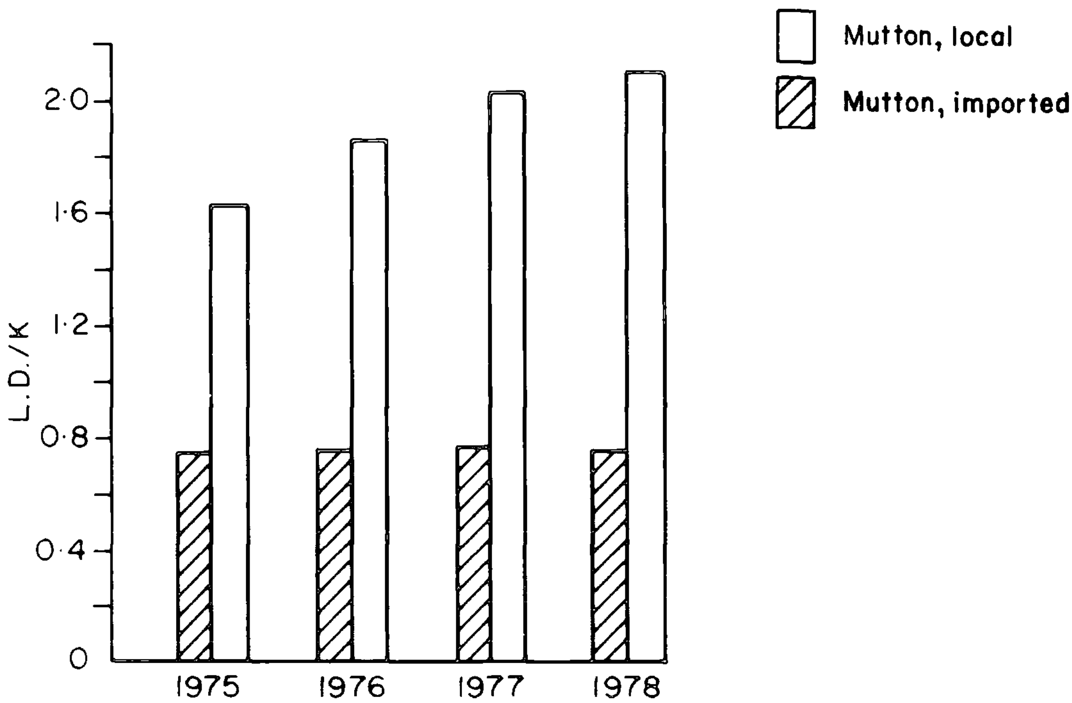
In general greater supply in open market condition will lead to a fall in price, but a reduced supply will lead to increase in price. The quantity of demand is that which consumers or users acquire at a certain price at a given moment. Sometimes a change in demand takes place which means that for the same supply level on the market the consumers are willing to pay higher or lower prices than paid previously when their income level rises or reduced respectively - price and income elasticities are both involved.

The influence of consumer taste in Libya and preferences for certain local agricultural commodities e.g. meat (mutton and beef), eggs, etc. generally makes the price for such commodities higher as the demand increases. For example, although the local mutton is more expensive than the imported, the Libyan consumers prefer local mutton to that imported from abroad from countries such as Bulgaria; the latter is said to be too fatty or is unpopular because Libyans do not believe in the way in which animals are slaughtered in the country of origin. Figure No. 5-2.2.3 shows a comparison of prices of the local and imported mutton.

Nevertheless, it is known that the average prices of certain other locally produced agricultural crops have been at a level lower than the average international prices of such commodities,[29] especially when the government subsidizes the producers and/or obligates them to sell at a fixed price which is not free-market realistic.

With a view to keeping down the level of the prices of certain basic food commodities - the Libyan government through the National Supply Corporation has been subsidising imported commodity prices below the import price. During 1974 alone, subsidies for this purpose amounted to approximately L.D. 43.2 m : L.D.5.5 m

Fig. 5-2.2.3
Comparison of prices of local and imported mutton



Source: Libyan Ministry of Planning, Quarterly retail prices in Tripoli City, 1975-1978 p.6 for wheat; L.D. 10.1 m for flour and semolina and L.D. 2.6 m for meat, among others. [30]

However, in the Tauorga project at present those products obtained from the reclaimed portions of the project are controlled and sold at prices fixed by the TPCS. If the planned settlement finally takes place, the prices paid to farmers will be the responsibility of the agriculture cooperative society (pp.111-112). This means, in short that the price paid to producers is fixed by the government. As the prices of agriculture commodities in Libya are increasing yearly, the prices which will be realised are at 1977 rate price. Table Nos. 5-2.2.9 and 5-2.2.10 show the yearly price increasing while at the same time the government is encouraging higher production specially the main crops e.g. wheat, barley, oats etc. and willing to buy them.

Table No. 5-2.2.11 shows slightly increased price of 1977 for onion as compared with the two previous years. The same Table shows that the prices of 1977 for tomatoes and potatoes are more or less the same as they were compared with the 1976 prices. Thus accurate estimation results are hopefully expected to be secured by using the 1977 prices. If any price for the year 1977 is not available for commodities such as wheat, barley and alfalfa, then the 1976 prices will be used.

<u>Value of off-farm surplus</u>

Two sources of price* information are available for this study, as we shall see, wholesale and retail prices. However, in

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* Currency which will be used in this thesis is the Libyan Dinar and its fraction the Dirham. Before 1970 the currency which was used is the Jinaih and its fraction the millim. However, both currencies are the same value.

Table No. 5-2.2.9 Government support price of Wheat L.D/Qu.1973-76 by Grade

Grade	1973-1974	1974-1975	1975-1976
I	7.950	8.000	9.000
II	7.125	7.200	8.000
III	6.375	6.400	7.000
IV	4.500	4.500	5.000

Source: Libyan Ministry of Agriculture and Agrarian Reform Achievement of the Revolution, Sept. 1969-Sept.1976 (Tripoli, 1976), p.48.

Table No. 5-2.2.10 Government support price of Barley L.D/Qu.1973-6 by Grade

Grade	1973-1974	1974-1975	1975-1976
I	6.450	6.500	7.00
II	5.850	6.000	6.500
III	5.250	5.400	5.800

Source: Libyan Ministry of Agriculture and Agrarian Reform Achievement of the Revolution, Sept. 1969-Sept. 1976 (Tripoli, 1976), p.48.

Table No.5-2.2.11 Wholesale Prices of onion, tomatoes, potatoes of 1975-1977 in Tripoli City

	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Average
Onion														
1975	-	-	0.110	-	0.040	0.050	0.040	0.050	0.040	0.043	0.050	0.095	0.518	0.057
1976	0.113	0.100	0.150	-	-	0.100	0.120	0.120	0.120	0.090	0.180	0.160	1.253	0.145
1977	0.517	0.700	-	0.050	0.050	0.070	0.040	0.038	0.050	0.035	0.035	0.060	1.637	0.149
Tomatoes														
1975	0.150	-	-	0.050	0.035	0.047	0.100	0.040	-	0.250	0.150	0.100	0.922	0.102
1976	0.200	0.230	0.260	0.500	0.500	0.183	0.070	0.050	0.050	0.020	0.020	0.235	2.318	0.193
1977	0.250	0.250	0.250	0.070	0.070	0.070	0.045	0.050	0.40	0.320	0.320	0.150	2.245	0.187
Potatoes														
1975	0.140	0.130	0.120	0.120	0.045	0.048	-	0.100	0.100	0.160	0.164	0.095	1.162	0.105
1976	0.080	0.110	0.113	0.166	0.096	0.073	0.120	0.110	0.110	0.150	0.150	0.137	1.435	0.119
1977	0.127	0.113	0.147	0.110	0.110	0.087	0.100	0.170	0.150	0.100	0.100	0.081	1.387	0.116

Source:- Libyan Ministry of Planning, *Quarterly Wholesale Prices in Tripoli City, 1975-1977* the present context the key prices which we need are those obtainable by the farmer - farm gate prices - or, in some cases, by the project in aggregate, and also the price cost of essential inputs. In general, what we may call wholesale prices in the project were planned to be largely under the control of an agricultural cooperative society. Thus the society would sell project produce, sometimes to other governmental project agencies, commodities such as alfalfa, grains, straw, etc and other times some products, e.g. vegetables and fruit on the open market. The society would obtain products from individual farmers through central purchasing power and the farmer would obtain farm-gate prices, which are the society's "wholesale" prices minus the society's commission of up to 3%, retained as an involuntary saving credit for producers and transport cost charged by the agriculture society. In Figure 5-2.2.4 is illustrated the possible flows and sales outlets for farm produce.

Let us assume therefore, first, that the farmers sales income can be calculated (as at least an order of magnitude) as:-

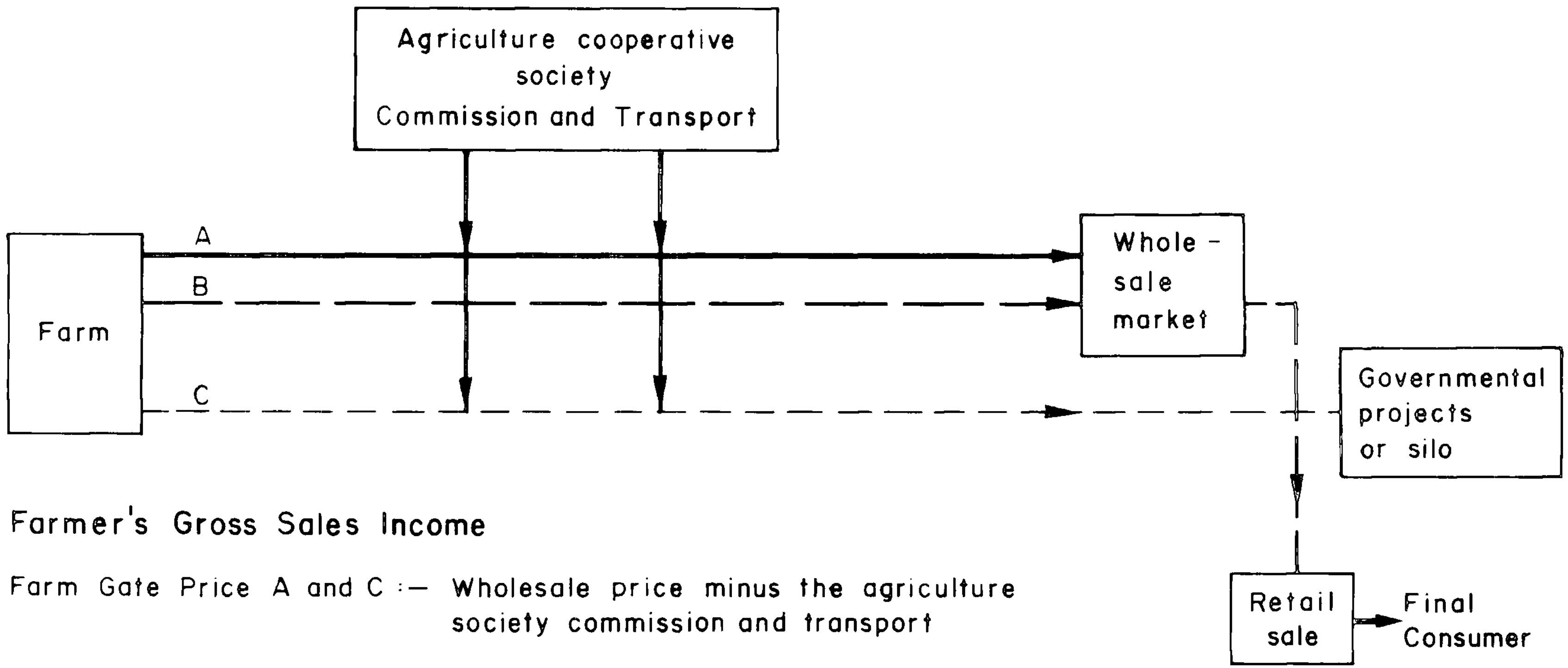
Volume of saleable surplus X Wholesale price - 3%
Commission - transport (in case A and C).

or as:-

Volume of Saleable surplus X (Retail price - Retail profit)
- 3% commission - transport (in case B).

If we apply either of these formulae to the various flows illustrated in Figure 5-2.2.4 and using estimates of either wholesale or retail prices, see Table 5-2.3.12 we can estimate the farm gate price and therefore farm gross incomes from sales. Whenever possible, in arriving at estimates of farm gate sales income, the wholesale price charged by the agriculture society will be used in order to diminish at least the margin of error.

Fig 5-2.2.4 Planned Flow of Goods from Farm to Market Outlet



Farmer's Gross Sales Income

Farm Gate Price A and C :— Wholesale price minus the agriculture society commission and transport

Farm Gate Price B :— Retail price minus retail profit and the agriculture society commission and transport

Table No.5-2.2.12 Wholesale prices of several agricultural commodities

Crop	Price kg/L.D.	Crop	Price kg/L.D.
Kidney Beans	0.195 (1)	Almond	0.30 (11)
Phaseolus	0.195 (2)	Citrus*	0.091 (12)
Watermelon	0.111 (3)	Grapes*	0.292 (13)
Potatoes	0.116 (4)	Alfalfa	0.125 (14)
Onions	0.149 (5)	Barley+	I,II,III classes are 0.07,0.065 and 0.058 respectively (15)
Tomatoes	0.187 (6)	Sorghum	0.08 (16)
Peas	0.256 (7)	Oats	0.096 (17)
Peanut	0.244 (8)	Beans,Vetch	
Wheat+	I,II,III & IV classes are 0.09,0.08,0.07 & 0.05 respectively (9)	Olives	0.135 (18)
Broad beans	0.181 (10)	Guava	0.200 (19)
		Pomegranate	0.110 (20)

\+ Production Grade III - for use in estimation

* No fruit trees now planted - estimated wholesale prices at 1977 rate used; the citrus price is based on 85.772% of the orange price, 8.934% of the lemon price and 5.342% of tangerine price.

Sources:

(1) Libyan Ministry of Planning, Quarterly wholesale prices in Tripoli City, 1977, Census and Statistics Department, (Tripoli).

(2) Loc.cit.

(3) Ibid, p.6.

(4) Loc. cit.

(5) Loc. cit.

(6) Loc. cit.

(7) Loc. cit.

(8) Ibid, p.3.

(9) Libyan Ministry of Agriculture and Agrarian Reform, op.cit., (Tripoli, 1976b), p.48.

(10) Libyan Ministry of Planning and Scientific Research, Collection of Census, Tripoli, 1977), p.3.

(11) Loc. cit.

(12) Ibid, p.6.

(13) Ibid, p.7.

(14) Libyan Ministry of Agriculture and Agrarian Reform, op.cit. (Tripoli, 1975b), p.6.

(15) Libyan Ministry of Agriculture and Agrarian Reform, op.cit. (Tripoli, 1976b), p.48.

(16) Yaqub, Y. Tammina, 5 December, 1977, verbal communication.

(17) Ibid

(18) Shaheen, A., Tauorga July, 1979, Letters communication.

(19) Ibid

(20) Ibid

Production cost

After obtaining the farm gate prices, it is necessary to know the farm gate cost of inputs to enable us to estimate the net total value of off-farm surplus. In the following pages the farm gate costs per ha, excluding labour which will be shown separately, is examined. Water charges are assumed to be nil.

As far as fruit production is concerned, neither the cost of plants nor the cost of planting will be considered under current cost per hectare, but will be treated as fixed input costs.

The planned production in the project area involves both single crop land use e.g. perennial fruit trees, and multiple crop sequences e.g. winter tomatoes followed by summer melons. In order not to over-complicate the analysis of the planned but not yet implemented production scheme designed by GAUDRL (Table No.5-2.2.1) certain simplifying assumptions will be made. First, the yield of fruit from established groves and orchards is taken, since this will give the top limit of income obtainable from fruit trees. The input costs to the area under tree crops, include average annual current inputs of fertilisers, insecticides for mature trees etc. Secondly, the effect of multi-cropping sequences in the area cultivated has already been accounted for in Table No. 5-2.2.2 and therefore input costs per ha. are similarly already considered, i.e. the area for which the cost of ploughing, fertilisers etc. has been computed is larger than the delimited project area under non-perennial crops.

Machines Input costs, excluding labour

Table No. 5-2.2.13 Machinery costs for vegetables
Per hectare

Agricultural process	price L.D. per ha.
Ploughing	1.750
Fertilizer spreading	1.250
Harrowing	1.250
Making furrows	1.250
Total	5.50

Source:- Speetzen H., Land Settlement Projects, (1974), p.376.

Table No. 5-2.2.14 Agricultural process cost for vegetables

Crop "Onion"

Item	Amount/ha.	L.D./unit	L.D./ha.
Seeds	1.25-1.5 kg (1)	7.000 L.D/kg (2)	9.625
Fertilizers (NPK)	600 kg	2.8/100 kg	16.8
Insecticides	-	9.6 L.D. (3)	9.6
Total			36.025
Crop "Tomatoes"			
Seeds	0.750-1.0kg (4)	9.000/1 kg (5)	7.875
Fertilizers(NPK)	600 kg	2.8/100 kg	16.8
Insecticide	-	73 (6)	73
Total			97.675
Crop "Water melon"			
Seeds	2.5 kg (7)	5.00 LD/kg (8)	12.5
Fertilizers(NPK)	500 kg	2.8/100 kg (9)	14
Insecticide	-	8*	8
			34.5

* It is an average estimated figure, based on the other vegetables.

Table No. 5-2.2.14 (Cont.)

Crop "peas"

Item	Amount/ha.	L.D./unit	L.D./ha.
Seeds	80 kg/ha. (10)	0.45/kg (11)	36
Fertilizers(NPK)	600 kg	1.2/100 kg	7.2
Insecticide	-	8*	8
Biological treatment	1.5	7.5/1 kg	11.25
			62.45

Crop "Kidney beans" **

Seeds	80 kg	0.75 (12)	60
Fertilizers(NPK)	600 kg	1.2/100 kg	7.2
Insecticides	-	8*	8
Biological treatment	1.5	7.5/ kg	11.25
			86.45

Crop "Phaseolus" **

Seeds	80 kg	0.75 (13)	60
Fertilizers	600 kg	1.2/100 kg	7.2
Insecticides	-	8*	8
Biological -reatment	1.5	7.5/1 kg	11.25
			86.45

Crop "potatoes"

Tubers	20-25 QU/ha (14)	0.15LD/kg (15)	337.5
Fertilizers(NPK)	1100 kg (16)	2.8/100 kg	30.8
Insecticide	-	30 (17)	30
			398.3

* It is an average estimated figure, it is changeable depending upon type of infection.

**Most resources give information as beans, but not specified as species.

Sources:-

(1) Yaqub, Y., Tammina, 5 December, 1977, verbal communication.

(2) Ibid

(3) Libyan Ministry of Agriculture and Agrarian Reform, Achievement of the Revolution during Five Years, (Tripoli, 1974), p.102.

(4) Libyan Ministry of Agriculture and Agrarian Reform, Tomatoes Cultivation (Tripoli, 1976), p.11

(5) Yaqub, Y., Tammina, 5 December, 1977, verbal communication.

(6) Libyan Ministry of Agriculture and Agrarian Reform, Achievement of the Revolution during Five Years, (Tripoli, 1974), p.102.

(7) Speetzen, H., op.cit., p.381.

(8) Yaqub, Y., Tammina, 6 December, 1977, verbal communication.

(9) Speetzen, H., op.cit., p.381.

(10) Yaqub, Y., Tammina, 6 December, 1977, verbal communication.

(11) Ibid

(12) Ibid

(13) Ibid

(14) Libyan Ministry of Agriculture and Agrarian Reform, Potatoe Cultivation (Tripoli, 1976), p.9.

(15) Yaqub, Y., Tammina, 6 December, 1977, verbal communication.

(16) Libyan Ministry of Agriculture and Agrarian Reform, Potatoe Cultivation, (Tripoli, 1976), pp.8-9.

(17) Libyan Ministry of Agriculture and Agrarian Reform, Achievement of the Revolution during Five Years, (Tripoli, 1974), p.102.

Table No.5-2.15 Machinery costs for grains
Per Hectare

Work	Price per ha.
Ploughing	1.750 L.D.
Fertilizer spreading	1.250
Harrowing	1.250
Sowing	1.250
Harvesting	5.000
Total	10.50

Source:- Speetzen, H., Land Settlement Projects, (1974) p.357.

Table No. 5-2.2.16 Agricultural process cost for grains

Crop "Barley"

Item	Amount/ha	L.D./unit	L.D./ha
Seeds	100 kg (1)	0.046 (2)	4.6
Fertilizers (NPK)	500	2.8/100 kg	14
Chemicals	-	10	10
Total			28.6

Crop "Wheat"

Item	Amount/ha	L.D./unit	L.D./ha
Seeds	100 kg (3)	0.053 (4)	5.3
Fertilizers (NPK)	500	2.8/100 kg	14
Weed control	-	10	10
Total			29.3

Crop "Groundnut"

Item	Amount/ha	L.D./unit	L.D./ha
Seeds	80 kg	0.250 (5)	20
Fertilizers (KP)	525 (6)	1.2/100 kg	6.30
Insecticide	-	28	28
Biological	1.5	7.50	11.25
			65.55

Table No. 5-2.2.16 (Cont.)

Crop "Broad beans"

Item	Amount/ha	L.D./unit	L.D./ha
Seeds	90 kg[7]	0.38/kg[8]	34.2
Fertilizers (PK)	600	1.2/100 kg	7.2
Insecticide	-	8	8
Biological treatment	1.5	7.5/1 kg	11.25
Total			60.65

Sources:-

(1) Libyan Ministry of Agriculture and Agrarian Reform, Barley Cultivation, (Tripoli, 1976), p.4.

(2) Yaqub, Y., Tammina, 6 December, 1977, verbal communication.

(3) Libyan Ministry of Agriculture and Agrarian Reform, Wheat Cultivation (Tripoli, 1976), p.6.

(4) Yaqub, Y., Tammina, 6 December, 1977, verbal communication.

(5) Ibid

(6) Libyan Ministry of Agriculture and Agrarian Reform, Al Falah (Tripoli, 1976), p.26.

(7) Yaqub, Y., Tammina, 6 December, 1977, verbal communication.

(8) Ibid

Table No. 5-2.2.17 Machinery cost for fodder Per Hectare

Work	Price per ha.L.D.
Ploughing*	1.750 (average price)
Fertilizer spreading	1.250
Sowing*	1.250
Harrowing	1.250
Harvesting+	3.000
Total	8.5

Source:- Speetzen, H., Land Settlement projects (1974), p.375.

Table No.5-2.2.18 Agricultural process cost for fodder

Crop "Alfalfa"

Item	Amount/ha	L.D./unit	L.D./ha
Seeds*	42 kg (1)	3.60 kg (2)	151.2
Fertilizers(PK)	500 kg	1.2/100 kg	6
Insecticide	-	20	20
Biological treatment*	2 kg (3)	7.50/kg (4)	15
Mowing++	9 times	1.50/once/ha	13.5
Total			94.9

Crop "Oats & Vetch beans"

Item	Amount/ha	L.D./unit	L.D./ha
Seeds**	80 (5)	0.046/kg oats and 0.589/kg vetch	21.056
Fertilizer(NPK	500	2.8/100 kg	14
Chemicals	-	8	8
Total			43.056

Table No. 5-2.2.18 (Cont.)

Crop "Sorghum"

Item	Amount/ha	L.D./unit	L.D./ha
Seeds	65(6)	0.125(7)	8.125
Fertilizers	500	2.8/100 kg	14.00
Chemicals	-	3.15	3.15
Total			25.275

* Every third year for alfalfa
\+ Except alfalfa
++ Average of 9 times a year
** 80 kg/ha. consist of 48 kg oats, 0.046 L.D./kg and 32 kg vetch, 0.589 L.D./kg.

Sources:-

(1) Shaheen, A., Tauorga, July 1979, letters communication.

(2) Yaqub, Y., Tammina, 6 December,1977, verbal communication

(3) Shaheen, A., Tauorga, July, 1979, letters communication

(4) Ibid

(5) Libyan Ministry of Agriculture and Agrarian Reform Oats and Vetch Cultivation (Tripoli, 1976) pp.4-5.

(6) China Republic, Report of Field Experiments conducted in Tuorga(Tripoli, 1967), p.10.

(7) Yaqub, Y., Tammina, 6 December, 1977, verbal communication

Table No. 5-2.2.19 Cost per hectare of fruit trees - Fixed capital

Work	L.D./unit	L.D./ha.	Remarks
Earth canal making	-	3.00	
Drilling holes	0.150/hole(1)	60,41.55, 93.75, 60, 124.95 and 93.75	cost per ha. obtained by: 0.150 x (number of trees per ha.)
Transporting, planting	1.360/tree(2)	544, 376.72, 850,544, 1132·88 and 850	
Trees or cutting	0.250/tree(3)	100,69.25, 156.25,100, 208.25 and 156.25	No. of trees* per ha. are: 400, 277, 625, 400, 833 and 625 for almond,olive, guava, citrus, grapes and pomegranate

* No. of trees per ha. is determined by the distances between trees and row, which are 5 x 5 m., 6 x 6 m., 4 x 4 m., 5 x 5 m, 3 x 4 m., 4 x 4 m for almond, olive, guava, citrus, grapes and pomegranate, respectively.

Sources:-

(1) Yousf, M., Tauorga, 10 November, 1977, verbal communication.

(2) Ibid

(3) Libyan Ministry of Agriculture and Agrarian Reform, Achievement of the Revolution during Five Years (Tripoli, 1974), p.15.

Table 5-2.2.20 Current expenditure per ha. on fruit trees

Almond

Item	Amount/ha kg	L.D./unit	L.D./ha.
Manure	4000	30/tonne	120
Fertilizers	600 (1)	2.8/100 kg (2)	16.8
Insecticide*	-	20	20
Total			156.8

Olive

Item	Amount/ha kg	L.D./unit	L.D./ha.
Manure	2700	30/tonne	81
Fertilizers	761 (3)	2.8/100 kg	21.308
Insecticide*	-	15	15
Total			117.308

Guava

Item	Amount/ha kg	L.D./unit	L.D./ha.
Manure	3475	30/tonne	104.25
Fertilizers	652.75 (4)	2.8/100 kg	18.277
Insecticide*	-	20	20
Total			142.527

Citrus

Item	Amount/ha kg	L.D./unit	L.D./ha.
Manure	5000	30/tonne (5)	150
Fertilizers	1000 (6)	2.8/100 kg	28
Insecticide	-	30	30
Total			208

Grapes

Item	Amount/ha kg	L.D./unit	L.D./ha.
Manure	4950	30/tonne (7)	148.5
Fertilizers	708 (8)	2.8/100 kg	19.824
Insecticide	-	25	25
Total			193,324

Pomegranate

Item	Amount/ha kg	L.D./unit	L.D./ha.
Manure	3475	30/tonne	104.25
Fertilizers	652.75 (9)	2.8/100 kg	18.2
Insecticide	-	20	20
Total			142.45

* Estimated average.

Sources:-

(1) Libyan Ministry of Agriculture and Agrarian Reform, Al Falah, (Tripoli, 1977), p.43.

(2) Speetzen, H. op.cit, p.381.

(3) Libyan Ministry of Agriculture and Agrarian Reform. Al Falah, (Tripoli, 1974), pp.25-26.

(4) Yousf, M. Tauorga, 10 November, 1977, verbal communication.

(5) Libyan Ministry of Agriculture and Agrarian Reform, Al Falah (Tripoli, 1977), p.43.

(6) Ibid

(7) Ibid, pp.18-19.

(8) Ibid, p.18

(9) Yousf, M. Tauorga, 10 November, 1977, verbal communication

Table 5-2.2.21 Total deduction of machinery and agricultural process costs of the Project's plan

Agriculture Commodity	Agricultural Production costs L.D.	
	per ha.	Per area
Kidney beans	91.95	10498.759
Phaseolus	91.95	10498.759
Watermelon	40.0	4567.16
Potatoes	403.8	46105.48
Onion, dry	41.525	4741.283
Tomatoes, fresh	103.175	11780.418
Peas, green	67.95	7758.463
Ground nut	76.05	34733.252
Wheat	39.8	6059.072
Broad beans	71.15	10831.734
Almond	156.8	23870.918
Olive	117.308	17858.735
Guava	142.527	21698.178
Citrus	208.00	31665.504
Grapes	193.324	29431.259
Pomegranate	142.42	21681.736
Barley	29.1	4430.126
Alfalfa	98.416	22474.081
Oats/Vetch	51.556	5886.612
Sorghum	41.275	4712.738
		331284.27

Table No. 5-2.2.22 Total gross income from the exported agricultural commodities

Agriculture Commodity	Quantities to be exported Tonne		Wholesale price L.D./kg	Gross income L.D.		Totalgross income L.D.
	Tauorga region	Tripoli		Tauorga region	Tripoli	
Kidney beans	9.506	558.993	0.195	1853.67	109003.63	110857.3
Phaseolus	3.166	426.482	0.195	617.37	83163.99	83781.36
Watermelon	71.976	80.037	0.111	7989.336	8884.107	16873.443
Potatoes	31.074	520.041	0.116	3604.584	60324.756	63929.34
Onion, dry	70.276	249.14	0.149	10471.124	37121.86	47592.984
Tomatoes, fresh	35.435	298.079	0.18	6378.3	53654.22	60032.52
Peas, green	3.166	321.441	0.256	810.496	82288.896	83099.392
Ground nut	35.341	910.358	0.244	8623.204	222127.35	230750.55
Wheat	95.841	28.989	0.070	6708.87	2029.23	8738.1
Broad beans,dry	9.505	89.788	0.181	1720.405	16251.628	17972.033
Almond	7.062	287.962	0.31	2189.22	89268.22	91457.44
Olive	80.643	282.735	0.135	10886.805	38169.225	49056.03
Guava	10.298	976.427	0.200	2059.6	195285.4	197345.00
Citrus	47.281	953.026	0.091	4302.571	86725.366	91027.937
Grapes	26.308	263.904	0.292	7681.936	77059.968	84741.904
Pomegranate	26.308	827.044	0.110	2893.88	90974.84	93868.72
Barley	-	124.804	0.058	-	7238.632	7238.632
Alfalfa	-	3642.995	0.125	-	455374.37	455374.37
Oats/Vetch mixture	-	779.842	0.096	-	74864.832	74864.832
Sorghum	-	955.678	0.08	-	76454.24	76454.24
						1945056.1

Transport costs:-

Transport cost is L.D. 13.50/tonne from Misurata-Tripoli, 211 kms, i.e. L.D. 0.064 per tonne/km.(31) Consequently we estimate transport cost per tonne from the Tauorga project to Tauorga regional market, 11 kms, is L.D. 0.704 and from the Tauorga project to Tripoli, 246 kms, is L.D. 16.896. The overall transport cost of the projected volume of commodity surpluses identified in Table 5.2.2.8 will be:-

To Tauorga region market	459.84	L.D.
Tripoli	212,513.92	L.D.
Total	212,973.76	

Transport costs can only be estimated by basing the probable rates on actual rate-charges made in other routes within the region. Normally road transport rates are arrived at, in this area on a tonnage basis, irrespective of type of freight. Too little produce moves at the present time out of Tauorga to enable us to do anything more than estimate by analogy.

Table 5.2.2.23 Total input - output for the project except Labourer costs

Item	L.D.	Remark
Total gross income	1945056.1	see Table No. 5-2.2.22
Agricultural Production costs	331284.27	" 5-2.2.21
Transport costs	212973.76	
Reduction by the Agriculture Society Commission 3%	11878.442	Agriculture Society commission retained as investment saving credit for producer
Total costs and reduction	556136.47	
Net total income	1388919.7	

Utilising Table No.5-2.2.23, the average net income per settler holding, excluding labourers cost, would be of the order of -

$$\frac{\text{Net total income (ex.labourers)}}{\text{Number of holdings}}$$

$$= \frac{1388919.7}{300} = \text{L.D. } 4629.732$$

Labour demand

a. For irrigation - the quantity of irrigation and leaching water demand by crops is shown in Table No. 5-2.2.24 below:-

Crop	Water demand p.a. cu.m/ha.
Fruit trees	22,990
Grains	23,476
Vegetables	29,184
Fodder	27,869

Depending on the length of the different lateral canals the average flow will be 90 L/sec to supply an average of 7.6 ha. cultivated area per settlement, i.e. 11,842 L/sec/ha. i.e. 42.631 cu.m/hour. Thus the average man-hours required on farm for irrigation per ha. and for the project area are as in Table No. 5-2.2.25 below:-

Crop	Man-hours	% of the project area	Man-hours in project area
Fruit trees	539.278	40	492,593.78
Grains	550.687	20	251,507.56
Vegetables	684.572	20	312,654.99
Fodder	653.726	20	298,567.12
Total			1,355,323.5

b. For fieldworks:-

In order to facilitate calculation, the labour inputs for field work will be based on the same cropping proportion of land use which would then give an average for each holding, 4 ha. of fruit trees, 2 ha, of grains and/or legumes & groundnuts, 2 ha. of vegetables and 2 ha. of fodder. Table No. 5-2.2.26 shows the type of work and the required man-hours:-

Table No. 5-2.2.26

Crop	Area	Work	Man-hours ha.	Frequency	Man-hours area	Remarks
Fruits 4 ha.	4	Handhoeing Top dressing Pruning & grafting harvesting	60 5 50 350		240 20 200 1400 1860	
Grains etc. 2 ha.	2	Handhoeing Harvesting Field collection Hay making	82.50 250.0 2.0 2.5		165 500 4 5 674	Summer crop
Grains	2	Accompanying the combine Field collection Straw	5.5 2 2		11 4 4 19	Winter crop
Vegetables 2 ha.		Preparing seed bed Planting Singling, thinning & handhoeing Handhoeing Harvesting	23 75 87.50 82.50 613.00	2 2 2 2 2	92 300 350 330 2452 3524	Summer and Winter

Table No. 5-2.2.26 (Cont.)

Crop	Area	Work	Man-hours ha.	Frequency	Man-hours area	Remarks
Fodder 2 ha	1	Making hay Heaping bales	5 8	9 9	45 72 117	Alfalfa (Winter and Summer
	1	Making hay Heaping bales	2.5 4	2 2	5 8 13	Oats & Vetch Winter
	1	Making hay Heaping bales	3 5	2 2	6 10 16	Sorghum Summer

Consequently the estimated man-hours required for field work are as shown in Table No. 5-2.2.27

Table No. 5-2.2.27

Crop	% of the project area		man-hours area
Fruit trees	40%		424745.88
Grains	20%	20% summer	153913.29
		20% Winter	4338.802
Vegetables	20%		804733.59
Fodder	20%	10% winter & summer	40419.366
		10% summer	1826.864
		10% winter	1484.327
Total			1431462.1

Consequently, the overall man-hours input required for the project area, excluding the centralised project requirement e.g. for pumps, maintenance etc., are:-

Man-hours	-	Irrigation	1,353,323.5
" "		field work	1,431,462.1
		Total	2,786,785.6

The hypothetical daily working time for a settler or labourer is 8 hours and it is assumed that they will work 26 days per month; this results in 208 hours per month i.e. a labourer input of 2496 hours per year for each full time worker. It is an over-generous assumption that only Fridays are not working days. In fact we should also consider holy days, low working efficiency during Ramadan, and if the policy aims at a higher quality of life are taken into account then there will also be vacations. The actual working year might then be as shown on page 225.

The number of the settler's families being 300 and it is most likely that only one full time worker per family will be available as opposed to two,* as it was assumed hypothetically (see pp.297 and 285). Thus 300 x 2496 hr.p.a. = 748800 available man-hours.

The aggregate difference between man-hours p.a. requirement and man-hours available, on the assumption that each settler family holding will have one fulltime worker then appears as follows:

2786785.6	-	required man hours
748800.0	-	available man hours
2037985.6	-	labour deficit in man hours

* personal observation of present practices

The annual project man-hours deficit of 2,037,986 (rounded off) would require in aggregate 817 additional labourers, on the assumption that each would work the same man-hour year as the full time settler-farmer. For each of the 300 farms, we are then faced with a demand for about 3 additional labour units - either to be hired or obtained from the settlers family. We therefore should assume that if we consider all the additional labour requirement has to be met by full time hired labour, then realistically the total demand in terms of personnel is of the order of 900 hired labourers. Based on the minimum monthly wage of L.D. 75 per month,* the annual cost of additional labourers per holding will be 75 x 3 x 12 = L.D. 2700. Thus an average settlers holding would have to carry an annual wage-bill of some L.D. 2700, which is a little more than half of the L.D. 4629.732 net income per holding. However this wage-bill would have to be met in order to achieve the production levels described earlier in this Chapter and demanded by the plan design.

Thus, the true net income per holding would be L.D.4629.770 minus L.D. 2700 = L.D. 1929.32 i.e. an average of 160.81 per month/holding.

Table No. 5-2.2.28 Input - output for the project area
Project aggregate position

Item	L.D.	Remarks
Total gross income	1,945,056.1	
Agricultural production costs	331,284.27	
Labourers Costs	810,000	
Transport costs	212,973.76	
Reduction of the Agriculture Society Comm. 3%	11,878.442	Agriculture Society Commission retained as involuntary saving credit for producer
Grand Total cost and reduction	1,366,136.3	
Net total income	578,919.8	

* assuming all Libyan labour

Project aggregate position:

As shown in Table No. 5-2.2.23, a net aggregate income from the project as designed, excluding hired labour, is L.D. 1,388,919.7. The wage bill of 900 hired labourers would be L.D.810,000 per annum. Thus the net income from the whole project area could be estimated as L.D. 1,388,919.7 minus L.D.810,000 = L.D. 578,919.7 i.e. L.D. 192.973 net income per ha.

The Libyan government policy as announced in 1978 in such settlement projects now is to guarantee a family income of L.D. 1200-1500 per annum.

As noted earlier the Tauorga settler family net income would be L.D. 1929.32 per annum (see p. 198) but other considerations also have to be taken into account.

1. The expenditure so far on the project of creating partly reclaimed land not yet finally ready for transferance to settlers, we have already established as L.D. 4,081.12 per hectare (see chapter 4, p. 92) consequently the total of expenditure of creating each settler's holding is already -

4,081.12 x 10 (has) = L.D. 40,811.2

2. During the early 1970's government policy implies that any new settlers in new land reclamation projects would have to purchase new holdings by a process of repayment of all expenditure incurred in establishing the holding, this over a period of years. In 1978, however, the policy was modified so that the settler would be given free family housing including all normal installations, and would be expected to repay only the equivalent of 25% of the costs incurred in reclamation and preparation of the agricultural area ready for cultivation.

Table 5-2.2.29 Estimated monthly family expenditure according to low income groups - Tripoli - 1974

Consumption Item	Value in L.D.	Consumption Item	Value in L.D.
Animal Products	8.325	Consumption goods (other than food)	2.955
Dairy Products	2.709	Fuel and Electricity	3.041
Sugar	0.968	Clothing and Textile furnishing	5.995
Drinks	1.964	Household Equipment and Durables	4.503
Oil and fats	2.831	Services and Personal Expenditure	11.367
Tobacco	2.494	Transport	3.339
Medical care	2.899	Education	1.064
Total	51.623		

Source: Libyan Ministry of Planning - Monthly cost of living index of Tripoli Town. (Tripoli, 1974) pp.68-70.

3. If we abstract from the total costs p.ha these items of grant i.e. items 3, 4, 5 and 6 in Table 4.1.1 (p.89) and items 1 and 4 in Table 4.1.3 (p. 91) then we arrive at an estimate of the costs which the settler should repay as a form of holding purchase, i.e. 25% of L.D. 3,279.560 p.ha = L.D. 819.89. Thus for a 10 ha. holding the repayment/purchase price per holding would amount to some L.D. 8198.9.

4. Since such repayment would have to be made from settlers' savings we must now estimate the order of magnitude of possible savings which a settler might make from net income. In Table 5.2.2.29 the most recent estimates of average Libyan household monthly expenditure are shown. Accepting that these are for urban households, and that, unlike the other financial data we have used, refer to 1974 rather than 1977, we can at least establish as an order of magnitude, that monthly household expenditure (excluding housing) by 1977 in Tauorga would be about L.D.70. From a net monthly income per settler farmer of about L.D.161 (p.198) the maximum monthly potential savings would be approximately L.D. 91, an annual rate of L.D. 1092.

5. If all such potential savings were devoted to even the post-1978 relatively low repayment rates, then it would take each settler over seven and a half years to complete purchase/repayment.

It is fully realised that this is an analysis of a hypothetical situation since land and housing have not been allocated and settler-farmer production and the whole marketing operation has not in fact been established. Nevertheless, it would appear that the economic aims of significantly improving rural incomes would have barely been met and that even the position outlined above depended on all the production and marketing systems working according to plan.

5.2.3 Improving the socio-economic and cultural situation included the following aims: (32)

(1) Economic Effects

a. Increase in the direct and indirect creation of wealth and acceleration of total economic growth:

i) by activation of idle resources and land reclamation
ii) by introduction and amelioration of agricultural processes
iii) by promotion of the creation of capital
iv) by improving the trade balance (saving of foreign exchange)

b. Promotion of economic stability:

i) by introduction of high yielding crops and animals
ii) by diversifying and commercializing production

(2) Social Effects

a. Improved distribution of income
b. Improving living conditions

i) health
ii) residence
iii) education

c. Occupation of the unemployed and underemployed

d. Modification of the rural population's and tribal way of living.

(3) Cultural Effects

a. removal of illiteracy
b. training of a critical mass of local expertise
c. introduction of cultural changes

(4) Political Effects

a. a move towards increasing national independence in the supply of agricultural and other products within Libya (this in association with other Agricultural projects)

b. internal effects within Libya - removal of regional disparities

The achievement of these demands depends partly on the income from the settlers' holdings and partly on the government's further provision of services, which are already supplied by the government. Under normal conditions, both the income from holdings and the governmental provision of services were planned to complement each other to operate towards the goal on a dynamic not static time as shown in Fig. No. 5-2.3.1.

In this project, however, it is doubtful if the proposed development process would in fact be initiated due to the problems mentioned in Chapter 6 particularly the virtual ignoring of the settlers education and training needs and the fact that the settlers' income is artifically, not naturally, created, as we have seen.

Governmental Provision of Services

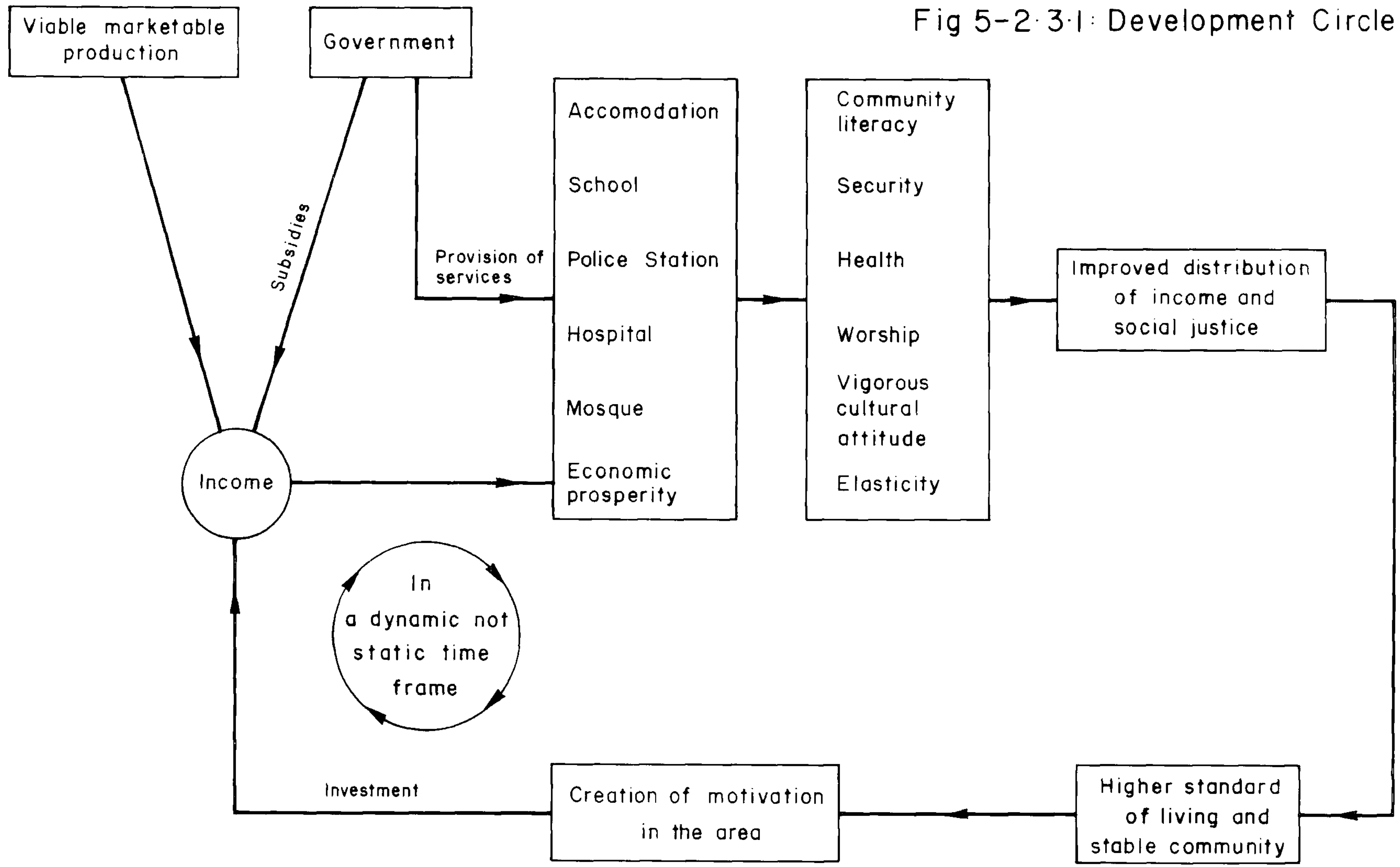
These are the services demanded by all inhabitants.Producers and consumers alike in part pay for these services through indirect taxation, whilst the supply of "free services" is decided by government. A school or a hospital, a police station or a health unit, a court or military defence, for example are all such services.

These services are the backbone of the country and can mostly, it is assumed, be supplied only be government because they require large financial backing, as well as national authorisation and organization. However, the case in the Tauorga project is that such services had been included in the project planning and constructed in the central village during the second phase, stage 1 of the project construction. The cost of such capital provision is met from state revenue which in the Libyan case is not significantly derived from taxation but from oil income.

The influence of governmental provision of services in terms of development

Settlers' houses: All settlers' houses are not yet constructed, but this could eventually occur. This would give the first step toward non-nomadic and permanent settlement of people who are in part still not wholly sedentarised. Their non-transferable houses

Fig 5-2·3·1: Development Circle



and farms and the required fulltime working of the holdings were planned to encourage settled life and consequently form a stable new community.

The Mosque is a very important and essential part of the central village because all settlers are Moslims and worship is the first priority of their life. The mosque also provides a place and times for meeting of members of the community and allow for better inter-communication .

The school is intended not only for children's academic studies but also at night will be used for free adult education, in particular to increase literacy. A certain standard of literacy is one of the conditions which a settler has to meet in order to be given a farm (see p. 43) Literate settlers will be more able to understand problems concerning e.g. quantities of fertilizers and how to use them, book keeping for his farm, agricultural magazines etc.

The hospital in the central village is the centre for health services for the settlers. Again, a reduction in mortality rates can not only increase personal happiness but should increase family stability. In combination with education, such provision is aimed to improve hygiene, attitudes to diet and a motivation to work for better living standards.

The Police Station will supply security in the project and will participate in dissolving problems and quarrels among settlers. Gradually the settler will remove the idea of "Me and my brother against my cousin; And me and my cousin against the foreigner" from his mind and he and his generation will get more used to discipline and order.

The Post Office will supply easy communication between the project and the rest of the country and enable project management, and eventually farmers, to be in touch with the market news such as demand, supply and price, etc.

A banking service is intended to encourage more sophisticated approaches to credit and the handling of money without entailing journeys to Misurata or Tripoli. Similarly, the project administrative buildings should enable project activities to be organised within the new community and diminish a sense of remoteness from the distant centres of power.

Also within the central village have been planned the necessary economic components of the new system. A central market was designed in general to provide a retail outlet for local and imported products, but was not envisaged as playing a major part in the marketing operations of the agricultural cooperative society. On the other hand, warehousing provision could be used for many purposes, by the settlers and by other agencies. The technical service station was to provide mechanical services and possibly machinery hire for the whole project and would encourage easier and cheaper access and exposure to non-traditional farming technology.

In settlement terms, the idea was to encourage communal activity and the integration of many small farm enterprises through a degree of centrality. What cannot be judged is how the balance between central control and the spontaneous growth of community responsibility would have developed. In particular, there is the question of how far the financially free provision of such services and therefore a strong role for central project administration would have affected the development response.

Conclusion

Throughout this chapter generously high orders of magnitude of production levels have been utilized and input costs equally conservatively estimated. Based on almost entirely 1977 prices, it can be maintained that net incomes forecast in the hypothetical plan were on the high rather than on the low side.

Originally each settler should have paid about L.D. 40,811.2 as the price for his holding, but government exemptions reduced this to L.D. 8,198.9. Thus at least L.D. 32,612.3 for each settler is written off.

Keeping in mind that the government would be committed in the future to support the settlers through the agriculture cooperative society without charging interest on subsidization or loans (see pp.20-22), this means that in this case oil revenue would continue to be expended rather than strictly invested in such agricultural establishments and the danger is that such project developments would remain parasitic on oil revenue, and not be self sustaining or making a net real contribution to national wealth.

In Chapter Six which follows, we examine the degree to which the planned development process corresponds with actuality.

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CHAPTER SIX

THE REASONS FOR DISCREPANCIES BETWEEN PLAN AND EXECUTION

In Chapter 5 we examined the plan and the progress of the development project, analysed the project's objectives, and have already identified the major discrepancies between plan and execution.

In this chapter causes of these discrepancies will be individually identified and analysed, and some recommendations which appear to be suitable to project conditions will be suggested.

Special attention will be paid to the problems and difficulties which appeared in the Second phase - Stage 2 but before elaborating on these problems we shall first attempt to identify the points associated with the success of an agriculture project. For success the following should be secured:-

1. The project must have been constructed according to the general design which grew from the interpretation of geographical, economic data and from the engineering point of view.
2. The output of the project must fulfil the objectives for which the project was designed, either socio-economic demand i.e. higher living standards, land settlement, or market demand for specific products.
3. The exploiting of physical and economic factors to achieve the goal must be stable and self-sustaining.

6.1 Phase Two - Stage 1

This stage, construction of the project was planned to be started on November 1970 and to be completed on November 1972, but the actual date of completion was early 1974.

The delay of almost two years was caused by various factors:

1. During the project construction there were six different companies involved in the project construction. These companies were, the Egyptian Boheira Company, the Land Reclamation Authority of the Libyan Government supervising Boheira Company's activities, the German firms KSB and Siemens supplying and installing the mechanical and electrical equipment, a second Egyptian firm, Hassan Allam Company responsible for the central village, and finally after March 1972 WAKUTI which was contracted as a consultant for the supervision of Boheira activities to reinforce the Libyan L.R.A.

Project construction included a range of activities on, e.g. the central village, the agricultural area, mechanical works, electrical installations etc. These required a specially capable and flexible management and organisational system but in practice the division of responsibility between three groups from March, 1972 i.e. the Land Reclamation Authority of the Libyan Government, WAKUTI Consultant Company, and Boheira Company, construction company, did not provide a totally relevant structure WAKUTI was brought to supervise a plan which was not their own but had been modified by Boheira from the earlier WAKUTI design and the gap between the consultants and the project builders produced problems due to different technical approaches as well as those of communication; even official correspondence was carried out in two languages, Arabic and English.

Furthermore, the obligatory presence of a representative of each of the above mentioned managements at site when each single operation was to be executed, e.g. during the pouring of cement for irrigation channels caused confusion and delay.

If in order to expedite work the construction contractor operated in the absence of representatives of other groups, the latter disclaimed all responsibility. In practice this led to waste of time, materials and money.

2. The frequent lack of construction material on site when required was one of the main causes for the project execution delay and arose from delays in delivery and port difficulties with imports. (1)

3. Financial difficulties arose in connection with the system of payment for construction work. According to the contract bill of quantities and specification the contractor could be paid only after the testing of completed sections of work. (2) This is common practice but given also very lengthy administrative procedures led to complications and delays in construction and to cost inflation.

4. The appearance of new types of governmental regulations and administrative systems after the 1st September 1969 revolution required a considerable time for adjustment of all engaged in this and other projects.

The delays in this stage, construction of the project, quite apart from other considerations, led to the late start of the second stage land preparation and to the dislocation of what had been planned as a carefully integrated operation. As we shall see later many of these problems appear in many other countries but they also had some specific implications for this project.

6.2 Phase Two - Stage 2

Those problems and the background reasons, some of which still appear, can be classified as follows -

A. Problems appearing because of technical mistakes in the execution of Phase 2 - Stage 1

1) Levelling:

During the construction phase, while performing original levelling, the top soil - cultivable layer - was removed completely leaving no soil at all in some areas i.e. Hosha No.31 Kata No. 13 Djosa Nos. 1 - 6 which had to be written off for cultivation. (3) Furthermore, the top soil was partly removed in several other areas leaving only thin layers for cultivation which creates great problems for performing the agricultural processes particularly leaching and irrigation. This improper levelling was caused by applying unsuitable machinery; e.g. tractor-hitched scrapers used for construction work were used instead of land-planers.

2) Irrigation canals

(i) The above was not the end of the problem, but the removed surface soil, which is particularly rich in salts, was used as base and embankments for the main, sub and lateral irrigation canals and also for the service roads in between the Djosas. (4) During periods of rainfall the salt content of the soil dissolved leading to erosion and gaps beneath and at the sides of the concrete irrigation canals. This led to the collapse of the main irrigation canal, several other sub-irrigation canals, and several culvert structures. Similar cases also happened in the central village.

(ii) It was then observed in the broken main irrigation canal sections that the lining concrete which according to specifications should have been 12 cm thick was only 2 cm;[5] thus it was possible that this weakness could also have been present elsewhere. Given the low mechanical strength of the salts-rich soil material such weaknesses become critical.

3) It was found that irrigation water could not be supplied to Hosha Nos. 13 and 14. This is caused by the fact that the level of the two lateral irrigation canals feeding those two Hoshas, were lower than the top soil surface level of these Hoshas. A considerable layer of this top soil was removed to alter the relative levels, but this did not solve the problem; on the contrary further problems of cultivating thin soil layers were created. These two Hoshas are now fed by water pumped up from these two irrigation canals, an expensive answer in terms of labour and other running costs.

4) Drainage system: Many of the lateral drains and sub-2-drains were executed with incorrect inclination and are not functioning properly [6] and the field drains are not deep enough to drain water. [7] Furthermore, the level of the two principal drains was not lower than the level of the project area, and consequently the drained water is not moving towards the sebkha, as it should be.

5) Subsidence of earth: In several places in the project, mainly under the central village's streets, pump station buildings, and other structures, subsidence of earth took place.[8] This was due to bad compaction of the earth, and, again, the high salt content of the soil.

These critical construction deficits became crucial when phase 2 - stage 2 started, because they were not identified early enough and because they were treated without due caution and care which led to a strengthening of their criticality and consequently very negatively influencing the progress of phase 2 - stage 2.

B. Problems appearing because of shortcomings in the execution of Second phase - Stage 2

1. Irrigation:

a. The progress in the project is permanently threatened by the almost continuous need of repair of the frequent breaks in the main irrigation canal. [9].

b. A problem which becomes increasingly serious is the leaking field inlets. [10] Many of them permanently allow water to enter the fields and thus are causing an increase in salinity.

c. Lack of labour control leads to the leaving open of gates all over the project and consequently water flows almost permanently into the fields. [11] Erosion, increase in salinity and waste of irrigation water are the results.

d. The amount of water applied to the fields varies greatly from specification. [12] In some cases the amount is too small whilst in others the fields (djosa) are almost flooded. Additionally, due to bad levelling, as can be easily observed, some parts of fields are flooded while others are dry.

e. Timing of application of irrigation water is irregular. Frequently regular irrigation is not possible because the irrigation system has broken down.[13]

f. Poor maintenance of the irrigation system because attention is mainly paid to the repair of cracks or collapses, but very rarely paid to avoid such breakdowns before they take place.

g. The electricity power supply in the project is not completely independent but is controlled from Misurata. Often cuts in supply take place which affect the project's water pumps operation. Thus the basic energy source for pumping, which is fundamental to water supply is not guaranteed, and this in a climate critical to plant survival.

2. Leaching (14)

The GCMAP was not able to carry out and control leaching processes in the areas shown in Table No.3.6.1.

During the work performance the following shortcomings were observed; these are of two kinds:

A. Shortcomings which were outside the control of the company : In the Djosas where soil had been partly removed and left with only a thin residual layer, leaching was very difficult indeed and sometimes there was not enough earth left to build up embankments.

B. Shortcomings which were the responsibility of the company :

1 - Due to wrong timing the amount of water applied is often too small.

2 - The embankments are frequently broken, thus an even distribution of water is impossible.

3 - The embankments around sink-holes often break and large amounts of water are lost.

4 - Often water is flowing uncontrolled into fields.

5 - The time between two processes is sometimes too long i.e. more than 4-6 days as required in the technical specification.

3. Drainage:

The earth-work team which was concerned with maintenance and repair work for drainage ditches (see p. 147) was not able to carry out annually all the necessary work in this respect. Consequently wild grasses, bushes, reeds and sedge were growing in the ditches, particularly in the principal drains, main drainage canal, sub-1-drains and sub-2-drains. Furthermore, some machinery such as the Poclain excavator which was used during the second phase - stage 1 for construction was also used for ditch cleaning, but since it was not the right equipment, the side slopes and the bottom inclination of the ditches were destroyed. It was not until the middle of 1977 that the right machinery was made available in the project. Additionally, the fine desert dust, which the Ghibli brings to the project, and eroded silt, completely filled some ditches, especially field drains and lateral drains.

As a result of all this and with the construction defects in mind (see p.213) the drainage system did not function properly and sometimes not at all. One result was a rise in the ground water table causing the following problems -

a. Re-salination

Since the salty water cannot be drained and evaporation is greater than the precipitation, the percolation direction goes upward through capillary action, i.e. the water evaporates on the surface and the sediments are left on the upper soil layer.

b. Toxic concentration of boron: Due to bad leaching and drainage toxic concentration of boron is now found in the soil. This phenomenon is a serious hazard since the concentration of boron is very high on at least half of the project. [15]

c. Sink Holes[16] : Sink-holes create problems for some parts of the project. The areas mainly affected are South and East but they also appear in other areas, as for instance Wadi Quedeiria although they are smaller and not only created through water, but initiated by rodents.* The sink-holes in areas East and South are created through water which causes sub-surface solution and collapse thus forming underground channels. When connections to the surface is established through collapse large amounts of water and soil disappear through them making agriculture very difficult, if not impossible. The sink-holes have to be temporarily surrounded by embankments in order to be able to continue reclamation work or agricultural production. In total there are 163 sink-holes which affect 544.2 ha. Furthermore, on 363 fields there are sink-holes under the inlet-structures. The location of sink-holes in the fields and those under inlet structure are shown in Table 6-2.1.

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* Innumerable rodent holes make the top soil layer collapse. This in due course leads to the development of sink-holes.

Table No. 6.2.1. Location of sink-holes

Hoshas	Area with sink-holes ha.	Number of sink-holes	
		Inlet structure	In fields
1 - 3	69.163	52	2
4 - 7	82.700	23	5
8 - 11	114.415	77	-
12 - 17	24.521	14	59
18 - 22	81.312	78	61
23 - 28	57.006	41	-
29 - 32	115.097	78	36
Total	544.214	363	163

Source: WAKUTI Final Report (Siegen, March 1977), p.57.

4. Levelling:

Originally levelling had been carried out on all fields during the construction phase 2 - stage 1, of this project (see p. 123). However, this basic land planing was later partly destroyed by inadequate soil cultivation, due mainly to the lack of experience of drivers and the poor condition of machinery. However, this led to a very difficult and sometimes impossible even distribution of water, which negatively affects the progressing of leaching and irrigation process (see p.214) Generally, levelling was carried out without the supervision of trained surveyors. [17]

5. Machinery and workshop:

a. Machinery adjustment: Bad adjustment of the agricultural machinery caused serious damage in the project. [18]

The basic land planing is already partly destroyed by inadequate soil cultivation which makes even distribution of irrigation water difficult. Bad machine setting led to seeds being placed too deep in the soil and there was also occasionally wrong seeding rates. This also led to mistakes in ploughing under of green manure. [19] The mowing process of alfalfa is usually carried out badly and on large areas the alfalfa is left uncut, and flattened by driving over it. [20] Uneven distribution of fertilizers has easily observable effects on germination and growing.

The supervisors were not able to help drivers to adjust their machines since their knowledge of adjustment of machinery in general was limited. [21]

b. Machinery Management:

Timing, execution, and performance in the field work are not adequate to make full use of the soil fertility and to build up a favourable soil structure. [22] Often cultivation processes are carried out on too wet or too dry soil and sometimes the order of application of tools is wrong i.e. applying spring tooth harrow instead of 32-disc harrow.

c. Workshop:

The mechanical condition of most machines is not good[23] (see Table No.5-1.3.5). This was mainly due to the very poor performance of the workshop staff who had little experience and were few in number. Libya relies on importing from abroad all machinery, equipment, tools and spare parts etc. and this causes frequent problems of delay in ordering and delivery. Furthermore, Libya also relies on foreign skilled labour who will leave the country when they feel that their wishes are satisfied regardless of the country's need for their presence. (see p. 255).

6. Cropping patterns:

Almost all the cropping patterns planned for the project in order to improve the soil physical status were either not carried out, or severely changed. This again was partly caused by the fact that schedules for ordering and delivering imported machinery, seeds, fertilizers, pesticides etc. took precedence over what was required in the design. Table No. 6.3.2 shows the date of vessels' arrival and delays experienced at Tripoli harbour, this itself a variable outside project control. As noted elsewhere, the tight biological farming timetable can be critically affected by such delays.

7. Weed control:

Large areas of the project have already been invaded by weeds and parasites, e.g. many fields of Hosha No.17 are covered with Bermuda grass.[24] Cynadon dactylon Bushes which are spreading fast all over the project grew wild in the area before the project was established but under the poor natural growing conditions only a few of them were able to survive. However, with the establishment of the project and ample supply of water and nutrients they thrive and have already occupied large parts of the project particularly Hosha Nos. 16 and 17. [25]

During the summer of 1975 several small areas infested with clover dodder Cuscuta trifolii were observed and since no measures were taken against that, several areas were invaded[26]. On several locations reeds which grow in the drainage ditches everywhere have invaded nearby fields. One feature which will always be found is the re-growth of the previous crop, for example, all over the project re-growing alfalfa is found in cereal fields. Where this occurs proper application of agricultural machinery is not possible.

8. Fertilizer:

At present most fertilizer is machine broadcast before seeding but this renders it subject to being washed out before the maximum benefit to the plants is derived. Furthermore, broadcasting by machine is not done accurately enough to guarantee an even distribution. Any second application later in the season is spread by hand, but without proper fertilizer pans and good training of labour is not effective.[27]

9. Inner wind breaks:

The inner wind breaks are not doing very well in stopping the dust from creeping into the project. Many field and lateral drains are partly re-filled with sand.

Furthermore, the blown wind is causing crops' lodging, such as those crops with long stems i.e. wheat, barley and oats and thus negatively affecting planted seeds and making harvesting very difficult.

10. Project management and organization

The overall management of this stage was carried out by the GCMAP, supervision and follow up by the TPSC, who were supported by WAKUTI and it is this divided management which ultimately must bear responsibility for most of the problems.

The management in this project was changed very often, particularly those personnel in leading positions (see p.110). It was not able to cope with the project's requirements for the operation and organization of its five key factors and four main headings in the right direction to fulfil the project's objectives. The TPSC's management situation was more or less the same as the GCMAP. In addition, the chairman of the TPSC was overloaded with duties and responsibilities because he was also chairman of other committees for supervising projects at

Misurata, Dafnia, Tammina and Kararim. (28) This was finally recognised by the appointment of an independent chairman for the Tauorga project at the end of 1975. WAKUTI's contract was not prolonged after April 1977 in spite of the need for their advice.

11. Soil analysis:

In spite of the availability of valuable equipment and facilities in the soil laboratory there was a wide gap between the way in which the soil analysis proceeded and what was necessary. There was poor contact and information exchange between the supervisers in the soil analysis laboratory and the project's areas supervisers, for example there are cases of a Djosa being cultivated with a crop intended to be ploughed under and after a few days the soil laboratory recommended that this Djosa must be leached. Such confusion led to a waste of money and time. Furthermore, the soil laboratory never recommended any chemical amendments such as acidification and replacement of sodium etc.

12. Lack of experience of labourers:

Several shortcomings appeared due to the lack of experience of the labourers.

1) Very poor knowledge in modern agricultural processes e.g. how to handle machinery properly, how to act against salinity, the need for careful control of irrigation water flows and spreading of fertilizer etc.
2) Low standard of work performance, including quantity and quality.
3) Extremely poor education.

13.Shortage of labourers and technicians:

A large number of Egyptians left Libya following the Libyan/Egyptian war of July 1977. (29) In the same year Libya expelled 13,700 Tunisians who were clandestine migrants. (30) These two facts had an adverse affect on the project progress, particularly affecting the leaching programme.

14. GCMAP Contract:

The GCMAP contract was based on the quantity of the work it performed (p.235) rather than the quality. In the case of irrigation the outcome was very bad and the quality of soil cultivation was worse. Many Djosas were irrigated according to a fixed schedule whether or not there had been rain, or whether or not other parts of the work were on schedule. (31)

In general, what has been described above is not intended to be hypercritical of operations but instead to identify the ways in which many of the requirements for successful implementation were either lost sight of or suffered from technical defects which were not assessed in their individual or total significance by management.

6.3 Analysis and recommendations for the Second phase - Stage 2

As phase 2, stage 2 is the stage which is under execution at present, problems and difficulties are hindering the progress of this stage and it is to these that we now pay attention. In the next few pages analysis and recommendations of some of the problems and difficulties are discussed.

1) Maintenance of the project:

This includes work on irrigation and drainage systems, central village, sink-hole and weed control to be carried out by the TPSC employing three teams of labourers (see p.147).

(i) Irrigation system : the number of labourers per team is not enough to perform the required work schedule, for instance if we examine the team for joint sealing we find a major deficiency see Table No. 6.3.1.

Table 6.3.1 Productivity of Team for joint sealing

Type of canal	Total length m.	joints per day/labour pieces	Total length per day 15 labourers	Required days for sealing
Main Irrigation canal	2,200	8	360	6
Sub-1-Irrigation	20,000	10	450	45
Sub-2 "	50,000	10	450	112
lateral	156,000	25	1,125	140
Total				303

Source: WAKUTI Final Report, Siegen, 1977, p.163.

This maintenance team consists of 15 labourers

Work days - actual

365 days per year
- 52 " (Fridays)
- 20 " Holidays
- 30 " vacation
- 12 " Ramadan

+ 251

Balance of work days

Required days for sealing	303 days
Actual working days	251 "
	52

That is, in order to fulfil the entire obligation the team is 52 days short per year. The other two teams are short of labourers also.

(ii) Sink- holes:

Table No.6.2.1 shows that there are 163 sink-holes which affect 544.2 ha. i.e. 23.8% of the project area. These sink-holes create problems for some parts of the project making agriculture very difficult, if not impossible.

Furthermore, the sink-holes under inlet structures cause a lot of water to be wasted. Surrounding the sink-holes by earth embankments, the method under use in the project at present in order to be able to continue reclamation works, is a temporary solution. However, there are two other methods of treating those sink-holes -

(A) Deep ploughing of the affected Djosas, smashing the compacted masses by track-laying machines, then levelling.

(B) Dig out the sink-holes with an excavator and investigate it thoroughly, refill with 30-40 cm of non-saline soil over sand, wet it and compact well by means of a vibrator machine. The first method is not recommended for the reason mentioned in pp.145-146) it is expensive and will bring salts to the surface. The second method is safer, cheaper and quicker and has proved to be a successful method.(32)

(iii) Drainage system:

Apart from shortage of labourers for maintenance, there is the problem of availability of qualified technicians to drive the right new machinery which arrived on site by mid 1977 (see p. 216).

(iv) Weed control:

A specific team to perform this job has never been appointed.

Weed control is carried out occasionally by GCMAP and TPSC general labourers.

2) Irrigation and leaching:

Problems and difficulties of irrigation such as the timing of application of irrigation water, irregular irrigation etc. caused by the frequent break down of the sysem are serious (p.214). Thus a general overhaul and, where necessary, a rebuilding of the system is required; make-shift repair is only a temporary solution.

(i) Border strip and furrow irrigation would be a more appropriate system instead of the mixture between border strip and basin system which is under use at present in the project area.

(ii) The revised technical specification concerning irrigation and leaching must be followed, but the present application rate of 500 m^3/ha requires revision since it is not generally effective now.

(iii) Basic irrigation and leaching training for the candidate settlers and accurate levelling are essential.

(iv) Very close supervision of the irrigation system and processes is, and will be, necessary.

3) Levelling:

As the flood irrigation method for the project area was proposed (p. 71), accurate levelling is always required. Levelling must be performed by the right machinery driven by an experienced technician and controlled by a properly equipped surveyor.

4) Machinery and workshop:

The machinery necessary for the project, and now lacking, must be supplied. As can be seen from Table No. 5-1.3.5 only 72.2% of the available machinery is ready for work, the rest is under repair (17.19%) or totally out of order (10.58%). This is mainly due to the very poor performance of the workshop, and the low standard of driving. So, the mechanical condition of all machines must be improved considerably. The required standards of work can only be achieved by an upgrading of personnel if the quality of work is to be satisfactory.(33)

5) Cropping pattern:

Imported Inputs: Libya depends on importing most of the required inputs for this project and difficulties of obtaining chemicals etc. at the right time always causes problems (p. 140) Delay of unloading the vessels at Tripoli harbour is considerable. Libya estimated the annual cost of congestion at $175 million due to this delay. (34)

Table No. 6.3.2 shows that delay is ranging between 4 and 45 days. However, this 45 day delay exceeds the specified period of date of starting seeding and date of finishing seeding of several crops shown in Table No. 5-1.3.1.

External to the project: Flexibility in the Libyan import processes is required, including avoiding the gradualistic administrative routine of import approval and giving priority to the agricultural sector's needs.

The project administration and management could contribute through advance preparation of detailed programmes of supply of required items so that the project would be supplied with spike

TABLE No. 6.3.2 Delay of unloading the vessels at Tripoli harbour

Date of report	Delay/days	Vessels No.
13 March 1977 (1)	24	69
March-April 1977 (2)	24	-
20 April 1977 (3)	25	70
1 June 1977 (4)	21	75
5 Sept. 1977 (5)	40	-
5 Oct. 1977 (6)	45	96
26 Feb. 1978 (7)	35	76
28 March 1978 (8)	10	17
23 April 1978 (9)	12	15
7 June 1978 (10)	5-7	-
20 June 1978 (11)	5-7	10
18 July 1978 (12)	4	6
18 August 1978 (13)	10	20
23 August 1978 (14)	10-12	25

Sources:-

(1) Middle East Economic Digest, vol.21, No.15,(London 15th April 1977), p.14.

(2) Middle East Yearbook, International Communication Ltd.(London 1978), p.99.

(3) Middle East Economic Digest, vol.21, No.19 (London, 13th May 1977), p.16.

(4) MEED, Vol.21, No.25, (London, 24th June 1977), p.13.

(5) MEED, Vol.21, No. 41,(London 14th Oct. 1977), p.19.

(6) MEED, Vol.21, No.48, (London 2nd Dec. 1977), p.23.

(7) MEED, Vol.22, No.12, (London 24th Mar. 1978), p.14.

(8) MEED, Vol.22, No.18, (London 5th May 1978), p.18.

(9) MEED, Vol.22, No. 22, (London 2nd June 1978), p.19.

(10) MEED, Vol.22, No. 25, (London 23rd June 1978), p.17.

(11) MEED, Vol.22, No. 27, (London 7th July 1978), p.21.

(12) MEED, Vol.22, No.36, (London 8th Sept. 1978), p.17.

(13) MEED, Vol.22, No.37, (London 15th Sept. 1978), p.17.

(14) MEED, Vol.22, No.44, (London 3rd Nov. 1978), p.19.

tooth harrows instead of spring tooth. Similarly, required items must be ordered at the correct time. This necessitates staff having experience in depreciation of machinery, spare parts and stores.

Crop choice: The suggested cropping pattern for the reclamatory cultivation, date, rate and quantity of seeds and soil preparation of soil for cultivation in the revised technical specifications seems to be realistic and thus should be followed as a strategy, but it should not be taken as inflexible but modified according to prevailing soil and climatic conditions, available seeds and previous crops.

Concerning the suggested permanent crop plan to be applied in the project (p.159), whilst it is true that vegetables are good cash crops, it should be born in mind that salinity should be considered in its full effects; not to be recorded as a scientific fact. Thus to recommend potato cultivation in this project is really surprising as the expected yield decrement due to water salinity alone is 50% (see App. - C). Guava is a fruit which is not well known to Libyans, and therefore before recommending this fruit and similar novel crops to be cultivated it must be known if they will be marketable.

Except for broad beans, all grains and fodder recommended in the plan seem realistic to be cultivated in the Tauorga project.

6) Internal Wind breaks:

The recommendations for selecting and planting trees and cuttings etc. (pp.140-145) are valuable in this project conditions and must be followed. However, a forestry expert must be appointed who will be responsible for advising and directing a trained team, which also must be appointed.

7) Fertilizers:

Specific and appropriate rates of fertiliser applications must replace the present haphazard methods and must be based on plant and soil analysis. For example, samples should be taken from the crops on each Hosha in the middle of every season and from the whole plant, except for roots,and the total content of N, P, K, Ca, Mg, Na, and B should be determined for the varying field conditions. Once established, the applications must be exact and controlled.

8) Management and organization:

The management failure in this project is partly due to rapid staff turnover, partly due to the lack of experience of its members in such sensitive projects and partly due to complexity of the administration and organisation . Obviously stable management is necessary in order to give continuity and therefore gain experience, but the changes in the position of personnel in management is partly due to moving experts to other positions or to other schemes and partly due to action by the peoples committees.

As the Libyan government is anxious to diversify its economy before oil revenues run out, increasing the productivity of the agricultural sector is the most likely hope for the future. However, for project productivity it would have been better if decisions such as management structure, the scheme's future etc. were dealt with only by the agricultural planning policy makers of the country or the Ministry of Agriculture, rather than involve many agencies with clear chain of command.

This absence of clearly demarcated responsibilities can be observed to affect everything from daily agricultural work to general project strategy.

9) Candidate Settlers:

The project's success depends much on the success of developing the settlers themselves. Programmes for educating and training the settlers were planned to start in Spring 1974, but actually only a few items of this plan were implemented and then only partially and not correctly, for example:-

a. A training programme for spreading fertilizers was started in 1975. On 10th June 1975, 11% of the candidate settlers attending the course were able to spread fertilizer correctly. However, on 8th July, 1975, 37.5% were successful, 50% were promising but 12.5% proved to be incapable of completing the task correctly. It could be claimed that the result of this programme was 87.5% success, while 12.5% represents temporary failure but this could possibly have been rectified if the one month period had been extended. However, in spite of this success this programme was not continued and was carried out for only 18 trainees i.e. 6% of the 300 candidate settlers.

b. On April 1975 a training programme for tractor drivers was started; by mid June 1976 12 i.e. 85.7% of the 14 who attended the course passed. However, their ability was examined by an authorised man from the driving licence department in Misurata, not by an expert in agricultural machinery, and specific tractor handling skills were never tested.

Additionally, the 14 candidates were selected from those who could already drive cars, but the question of whether or not they were candidate settlers never arose.

The candidate settlers urgently need education and training to cope with the modern agricultural processes designed for the project. Unless this is given all the problems associated with the project will not disappear. At the heart of the project was the hope of a final group of skilled commercially viable farmer settlers but their training was never seriously undertaken, and this will have to be rectified if the essence of the project objective is ever to be fulfilled.

10) Shortage of labourers and technicians:

Libya depends mainly on Egypt and Tunisia for its labour force requirements but due to the bad relationship between Libya and these countries, the Egyptian and Tunisian labourers left the project. This had very damaging effects in several other agricultural development schemes in Libya, as well as in other sectors, such as construction. The same dependance applies to technicians, engineers, administrators etc. where Libya depends on the above mentioned countries as well as on Sudan, Morocco, Syria, Jordan, Palestine, and European countries. The recent turn to a greater reliance on non-Arab countries such as Pakistan, Jugoslavia, Turkey, U.K., U.S.A., Italy, Bulgaria and Rumania etc. has certainly increased costs in wages and salaries as well as language problems for employees not speaking English and Arabic. Obviously it would be to the mutual benefit of Libya, Tunisia and Egypt if friendly relations could be maintained.

Libya also has to build a technicians base for itself for the reason mentioned (pp.107&220) and, most important, recognise this through technical training on a regional basis.

11) Soil:

Some recommendations for improving soil management are appropriate here.

A - Leaching

1. Salts:

(i) Soil study, sampling and leaching processes in the revised technical specification (p.146) seems to be realistic, as one studies the soil of this project in detail, and must be followed.

(ii) Basic training for the candidate settlers in proper levelling and understanding the need for the control of salinity is essential.

(iii) Very close supervision of the leaching operations is required.

2. Boron:

The toxic concentration of boron (p. 217) is very high on at least half of the project area and it should be carefully monitored by regular checks of soil and plant samples. Considerable depths of leaching water may be necessary to reduce the boron content to a safe value for good plant growth.

B - For further reclamation of the soil in the project :

(i) Acidification is recommended and thus the use of ammonium sulphate and superphosphate should be continued for further acidification.

(ii) Replacement of sodium [35] chemical amendments for replacement of exchangeable sodium would be soluble calcium salts (calcium chloride, gypsum) and acid or acid-formers (sulphur, sulphuric acid, iron sulphate, aluminium sulphate, lime-sulphur).

The amount of gypsum or sulphur which would be needed for the replacement of indicated amounts of exchangeable sodium would be about 4 tons/ha.of gypsum or 0.8 tons/ha. of sulphur for each 1 milliequivalent of exchangeable sodium per 100 gr. of soil at a depth of 30 cm.

12) GCMAP Contract:

The improper irrigation and soil cultivation are partly caused by the unrealistic contract between the company and Ministry of Agriculture. Until the end of 1977 progress in the project was jeopardized by the reluctance of the company to carry out additional work without having their bills settled first. Conversely, during the rainy period the situation arose where some of the company's work was superfluous as the rain replaced the need for irrigation. With their contract in mind it was therefore not surprising that the company was inclined to carry out as much work as possible regardless of its necessity and the results.

Therefore, it is strongly recommended that the company should have a more realistic contract, i.e. a contract based on the requirements of the fields and not one which only eased the work of the administrators.

6.4. Problems due to inadequate and vague preparation and recruitment for the project's objectives approach

These problems are illustrated below -

1) Although the sink-holes phenomenon was early recognised and mentioned by Gilchrist et al, 1961 [36] and it was recommended to cultivate the affected areas only with trees or date palms, it was not until September 1976 that a decision was taken to cultivate some of these sink-hole areas with date palms instead of field crops.

2) Size of holding:

Firstly, study of the soil in the project area (see App.B1-B3) reveals that the soil has a considerable spatial variability in texture and structure. Consequently the fertility of the soil is variable throughout the area and gives rise to different crop yields.

Secondly, the cost of transport of inputs to and outputs from the agricultural system increases proportional to the distance from the central village to the farm.

The proposed farms to be established in the scheme are about 10 ha. holding each, but if farms of this size are created then several problems will be encountered, including inadequate income distribution in the region. Furthermore, not all settlers will be content with the distribution of land.

As far as fertility is concerned, the settlers will accept 10 ha. in the wadis but will be discontented if they are allocated land in the Eastern area of the project as can be shown in the comparison table below -

Table No. 6.4.1 Comparison between the Wadis and the Eastern area of the project.

Wadis e.g. Hosha No.17	Area east of the project e.g. Hosha No.18
1. Top soil is thick enough to be cultivated and the calcrete layer is located into reasonable depth.	1. Top soil is thin and the calcrete layer is located at a critical depth.
2. No problems of drainage and the ground water table is not critical so far.	2. Problems of drainage and the ground water table is rising continuously.
3. No sink-hole problems.	3. Sink-hole problems.
4. It is already reclaimed and under production stage and no problem of high salinity.	4. Problems of leaching and reclamatory cultivation due to high salinity.

Clearly a farm in Hosha No.17 is more productive than a farm in Hosha No. 18.

The same thing is applicable if the distance is concerned as shown in the example below:

Area West e.g. Hosha No.2 median point is 2.3 km by road from the central village while area to the south e.g. Hosha No. 32 is 11.5 km; thus in the second case the settler will pay more for transporting inputs and outputs than the settler in the first case; also both settlers are living in the central village so the settler in the second case has to travel more daily.

In any settlement project the appropriate size of farm must be determined according to the type of soil and other factors. In order to establish the correct size of holdings, trial farms in different areas of the project have to be established. The purpose of these farm studies is dual -

(a) to determine the settler's capacity to raise capital,

(b) to estimate overall production income and expenditure throughout the project.

The capacity to raise capital refers to the amount of money that the settler can set aside each year to pay for participating or sharing with other settlers to establish small scale agricultural installations and for investing in secondary activities capable of generating self-sustained growth in the area. The potential for raising capital may be calculated by deducting the following items from his income :

(i) Cost of producing and marketing his products, taxes and perhaps interest on possible long-term loans* obtained for purchasing the land and payment for installation of equipment.

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* No interest on loans in Libya at present.

(ii) Expenses necessary to maintain the ~~facility~~ family at its present standard of living or at a standard compatible with the socio-economic and political objectives pursued.

This requires assessment of alternative farming strategies and the calculation of the corresponding income and expenditure budgets of settlers. This will provide an objective basis for deciding on the appropriate size of farms.

Estimates for the entire area : with the income and expenditure budgets for farms representative of the different types of soil and with the general information such as soil, climate, market situation, manpower situation and current inventory of agriculture equipment...etc. overall estimates can be made for the project in order to find out how much the project can contribute to the national output.

Conclusion

In any settlement project -

(1) The fertility of soil must be considered.

(2) The distance from the farm to the market must be taken into consideration since transport cost influences cost of production and marketing for settlers.

(3) The above two mentioned items and other aspects such as standard of living should therefore be taken into consideration in deciding on the size of farms. It could be expected that the size of farms might be 10 ha. in some areas while in others they could be 7 ha. depending upon the type of the soil and the distance from the market.

(4) It is very necessary to find out the number of hectares which the settler and his family can operate in order to find out if he has to hire labourers or not.

(5) Some candidate settlers who are working in the project as monthly paid labourers already realize the nature of the project's soils. Every one attempted not to work in areas East or South of the project for the following reasons -

a. There are more and difficult works to be performed in these two areas.

b. They believe that it is most likely, in the future, they will be allocated the farms on land on which they are now working.

3)Project location:

Although the project location on the highway is advantageous particularly if transport and communication etc. is concerned, detailed site considerations must include the fact that the highway splits the project into two halves from North to South (Fig3.5.1) This is disadvantageous because:-

(1) This highway is very busy with traffic because it links the two largest cities in Libya, Tripoli and Benghazi, and Tunisia with Egypt. Nevertheless it will be necessary for agricultural machinery and other normal project traffic to cross this highway.

(2) The project area is not a simple consolidated block, that is to say there are several entrances through which anyone or anything can get into the project; this has caused several problems such as the indigenous animals attacking the windbreak shelter and sometimes even crops. The solution was to appoint watchmen, another consequential labour cost.

Furthermore, the field test trials could not be performed properly because the crops were often harvested prematurely by locals before the necessary statistics were recorded.

(3) The spatial dispersal of the various project areas has to be examined in the context of centralised residence for the proposed

settlers in the future. Of course there is no way now of altering the highway or the project location, but in the future such things must be considered.

4) <u>The central village location in the project</u>:

The central village is located in the extension of Hosha Nos. 3 and 4 (see Fig. No. 2.1.2) which lie on prime arable land. It is known that there will be more agricultural problems in the area East of the project. Surely it would have been advantageous if the central village location had been selected in the area East of the project on the poorest land; the better land being used for farming with no difference being experienced as far as transport or distance are concerned. No major construction problems should be encountered in this proposed resiting and those which are present could be more easily dealt with in an urban context rather than a farming one.

5) <u>Field Trials and Yields</u>:

A preparation of statistics on crop yields from the different soil types was one of WAKUTI's obligations during the contract period.[37] At the time of the arrival of WAKUTI supervisory team in Tauorga little was known about the performance of crops under local conditions. Therefore field trials were recommended for a wide variety of crops including carrots, squash, onions, garlic, lettuce, cabbage, sweet corn, spinach, tomatoes, eggplants, pepper, melons, cauliflower, parsley, beets, cucumber, peas, okra and beans. However, during the summer season of 1975 the only recommended plants to be grown were tomatoes, melons, pepper, egg plants and cabbage.

During the summer season of 1976 further trials were carried out and the following crops were grown - watermelon, tomatoes, squash, pepper, cucumber, musk melons, lettuce and okra. But except in the case of water melon and tomatoes, yield could not be recorded in either of the two seasons. However, the following crops were grown and their yields were recorded - alfalfa, barley, wheat, oats, maize, sesame and sunflower.

The above mentioned crops, which were grown as field trials, are not exactly those which are recommended to be applied as a permanent cultivation plan by the GAUDRL of Egypt (Table 5-2.2.1) Furthermore, some of the crops grown as field trials were not recommended at all in the permanent plan.

6) Crop protection system:

This item was completely missed and was not mentioned in the original technical specification.* No technicians were available and no equipment and chemicals when the first need occurred. On 22nd July, 1975 aphids were observed in cabbages in Hosha No.15[38] and on 9th September, 1975 the alfalfa all over the project was infested by Proclenia litura but no measures were taken.[39]

It is true that the project area covers a virgin soil but this does not justify the omission of crop protection because -

(1) The project area is exposed to winds which are capable of carrying the seeds of weeds or insects from the cultivated fields of the neighbouring Tauorga Oasis which are about 15 kms away or from Kararim which is about 18 kms away. It is important to consider that there are many insects capable of travelling such distances e.g. grasshopper, crickets, lepidoptera and coleoptera etc.

(2) At the same time the population of rodents within the project increased to the extent that their innumerable holes caused sink-holes and destruction of embankments.

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* It is introduced in the revised technical specification (see p. 131).

The project area has already been invaded by weeds and parasites. The most dangerous ones which are already causing problems are Bermuda grass, bushes, clover dodder, reeds and re-growing plants of previous crops. Again it is important to consider and prepare for such elements when establishing an agricultural project.

7) Hydrological Catchment area:

Hosha Nos. 15, 16 and 17 were originally part of Wadi Gilgel and Wadi el Hauat (Fig. 2.2.1) in which the flow direction is from west to east (see p. 57) towards the project area. The annual precipitation is about 125 mm and most of this falls from September to March.

Despite the known fact that maximum rainfall intensity can reach 25 mm/day, no provision was made to protect the project area from the effects of heavy rainfall. Consequently, as a result of heavy rainfall on September 1975 the inlet of the pipe culvert structure of sub-1-drains No.7 was damaged. [40] The side slope, the backfill of the structure, together with 250 m of slope toe protection etc. were destroyed. During November/December 1975 a 400 m earth dam was constructed in the catchment basin to protect the project area. [41]

Again such essential items should be considered and established when planning any project.

8) Drainge:

The drainage system in this project consists of open ditches over the whole area. The failure of this drainage system to operate properly, which resulted in a high water table, sink-holes and impeding reclamation is attributed primarily to bad maintenance of those ditches and construction defects of the principal drains.

However, there are other reasons which have a role in preventing the ditches from functioning. The advantages of using open ditches are as follows:- [42]

1. Open ditches usually have a smaller initial cost than buried drains.

2. Inspection of open ditches is easier.

3. They are suitable in soil where buried drains are not recommended.

4. Open drains may be used on a very flat surface where the depth of the outlet is not adequate to permit gravity flow from drains installed at the required depth and grade.

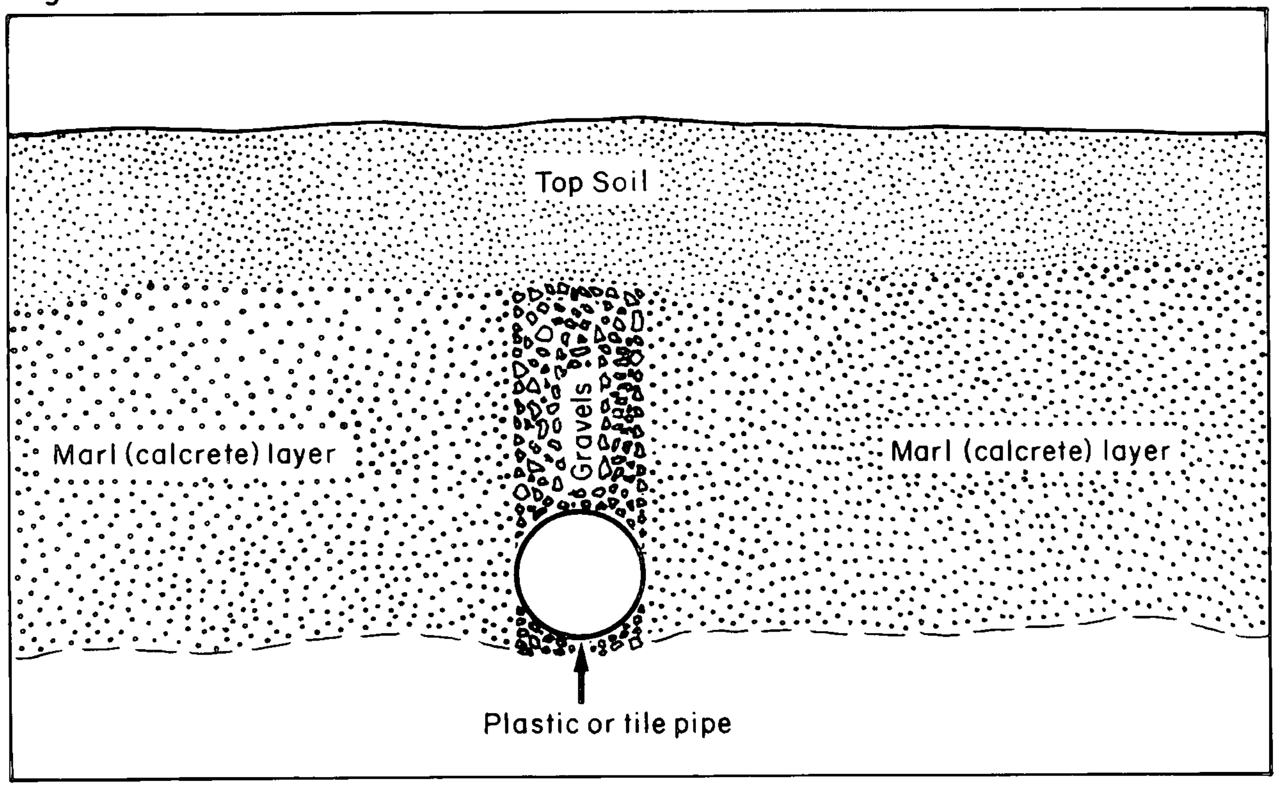
The disadvantages are: [43]

1. Open ditches require more frequent and costly maintenance than buried drains.

2. Open ditches require considerable right-of-way zones which reduces the area of land available for other purposes.

In evaluating the advantages and disadvantages of drains and ditches, their relative costs and ease of establishment should not be the only criteria considered. In addition, the soil response in terms of leaching must figure prominantly. An original study of Tauorga soil showed that the permeability of the loess and its subsoil is very high[44] and since moreover such salts as are concerned being easily soluble can easily be leached. The soil texture analysis (App - B3) shows that the soil contains silt and clay, and it could be that these particles have blocked the lower layer (marl layer). This, coupled with the fact that the water table is continuously rising means that the drainage system adopted for the project should include a combination of open and buried ditches. The field and the lateral drains must be

Fig 6·4·1 PROPOSED BURIED PIPE – DRAINS



converted into buried ditches, and perhaps additional buried ones within the fields themselves, while the rest could stay open after consideration of their inclination. Fig. No. 6.4.1 shows the type of the proposed buried pipe. By this method, hopefully, the buried pipes will lower the ground water table and consequently the resalination and sink-hole problems will be reduced.

Furthermore, extra land will be saved for other purposes while the size of the plots will be increased thus making it easier for agricultural machinery to operate.

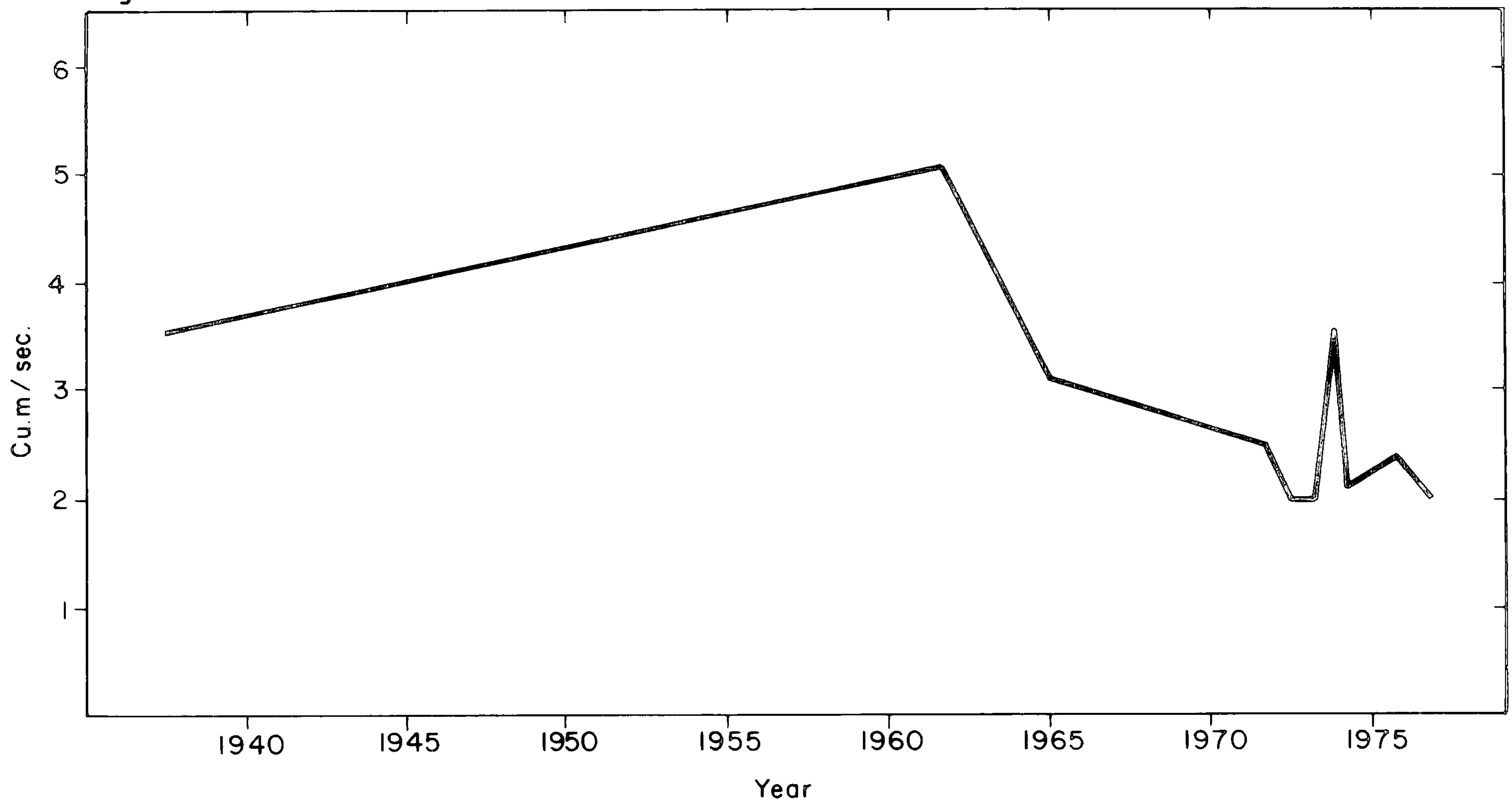
9) Tauorga Springs Discharge:

The project area depends on Tauorga springs for irrigation water but their discharge fluctuates (see Fig. No. 6.4.2) These fluctuations appear to have been caused by an increase in water extraction from the wells drilled near the springs in recent years, but the general question of control of water extraction and competition between wells and springs must be discussed.

The permanent cultivation plan which was recommended by GAUDRL is based on a springs discharge of 3.02 M^3/sec, taking into account the needs of the inhabitants and the experimental farm requirements (see p. 64). Measurements carried out between 1970 and 1977 show discharges less than 2.02 cu.m/sec apart from measurement No. 7 which can be disregarded because it was exceptional. These fluctuations confirm the experience of other Ministry of Agriculture and Agrarian Reform projects. The Regional approach called "Misurata farm development scheme" comprises the following stages :

1st Stage: Integration Development of the present farms as shown in Table No. 6.4.2 following (45)

Fig. 6.4.2. WATER FLOW FLUCTUATION



Region	Area hectare	No. of farms	Size of each farm	Irrig- ated	Unirrig- ated
Dafnia	9505	318	30	7	23
Tammina	4600	370	12	8	4
Kararim	1200	98	12	5	7
Total	15305	786			

2nd Stage: Reclamation and development of 6920 hectares in the above mentioned regions, to be divided into 358 farms as shown in Table No. 6.4.3 below - (46)

Region	Area	No. of farms	
Dafnia	4100	137	
Tammina	2600	203	2820
Kararim	220	18	

The project was initiated on 15th February 1973 by the Libyan General Company for land Reform under the Yugoslavian-Hydroproject Company.(47) The implementation of the project necessitated the drilling of 99 bore holes in the three regions and the construction of 45 water reservoirs. (48) Here the question of competition of those bore holes with the springs arose.

It was mentioned clearly that a study is being carried out in order to establish the relationship between the Tauorga springs and the bore holes which will irrigate the 2820 hectares in Tammina and Kararim (49) shown in Table No. 6.4.3. It is also mentioned clearly that the volume of work already executed is 60% in the 1st stage and 50% in the 2nd stage. (50)

The attached figure and the data on which the Misurata farm development scheme started, prove that there is competition between the Tauorga springs and the drilled bore holes.

Since there is doubt about the relationship between the Tauorga springs and the neighbouring areas then it is questionable why the 2nd phase of the Misurata farm development scheme, which is already 50% operational, should have been initiated. This question is left for the Libyan government to deal with. Either the 2nd phase of Misurata farm development scheme has to be stopped in order to save the water for the Tauorga project, or perhaps the cropping pattern in both projects can be altered to concentrate on crops which require less quantities of water. The latter is not expected to be effective. The most important factor which limits the agricultural development in Libya is the availability of water. Thus it is very important that before taking a decision for constructing an agricultural project that complete knowledge of the hydrological and the geological situation of the area is known.

6.5 Classification of the problems

When considering the problems identified under 6.1 - 6.4 one can arrive at the conclusion that there are three basic types of problem which can be identified in relation to development projects -

1. Standard (universal) problems which appear, for example, in any irrigation agricultural project all over the world e.g.

(a) Salinity is a fact as well as a problem. Salinity can seriously damage the entire crop or hinder growing or reduce quantity and quality of the products. Salinity has a potentially negative action in any irrigation-based agricultural project.

(b) High water table : soils derived under conditions which require irrigation for cultivation will need to be leached by the application of some quantity of water over and above plant requirement. This quantity of applied water is very critical because it is bound to alter the natural water table and this, in turn, requires exact control if plant growth is not to be inhibited.

2. Problems associated with LDC's - such problems result from shortage and lack of experience in several key aspects, such as general planning, construction, management and technological skill, and shortage of reasonably skilled labour. In practice we find, for example :

(a) construction defects i.e. several defects mentioned under 6.2 - A such defects would be less likely to happen if this project was constructed in a developed country because there would be a greater capability in responsible authorities and agencies constructively to criticise design.

(b) management: project management is a science which deals with the organization and operation of the project in a manner which would secure a high probability of success. Unstable management, lack of experience and poor ability of formulation of future expectations are generally characteristic of L.D.S's. Such problems may not appear as often in developed countries because most managements have enough experience, can apply mature judgment, are able to formulate the necessary implementation actions, and take sophisticated decisions about level and combination of products to be produced in the future.

(c) Technicians and labourers: However much importation of construction and management expertise is possible, the lack of experienced technicians and labourers who in the end carry out all the operations leads to losses and delay in performing the agricultural processes and eventually lead, possibly, to the failure of the project.

3. Specific local environment associated problems, e.g.

- Re-salination due to comparatively high temperature and evaporation greatly in excess of precipitation. In arid and semi-arid regions re-salination within plant root zones will take place more quickly than in more humid regions.
- Ghibli, a hot dry desert wind from south-east to south-west with fine desert dust (see p. 49) causes re-filling of drains and wilting of long stemmed crops.

The water quality i.e. 2.4 mmhos/cm conductivity at 25^{o}c restricted the range of valuable crops which would be cultivated.

Schematically, we can illustrate this three-fold classification, as in Table 6.5.1, where we distinguish three different national contexts for projects and key inputs.

Table No. 6.5.1

Item	Libya	India	England
1. Planning, design and know how.	Have to be imported from abroad.	Need some help from abroad	Available
2. Construction	Defective	Occasionally defective	Very seldom defective.
3. Capital	Extensively available	Scarcity	Minor problem
4. Management	Little experience	Experienced to an extent	Highly experienced
5. Technologists	Short in supply, inexperienced	Abundant, but lacking in experience	Available and well experienced
6. Labourers	Inexperienced	" "	" "

6.6 Governmental action to counteract the deterioration in project implementation

During 1974/75 the Libyan government noticed the poor progress of the project and realized that corrective plans were needed in order to rescue the project from total collapse and to direct the project once more towards its initial goals, while apparently the situation could still be controlled. Thus the government recommended the following to be carried out:-

A. Evaluation of the GCMAP performance.

B Evaluation of the present and future agricultural potential of the project.

Under a Ministerial Act No. 399 for 1975 by the Minister of Agriculture and Agrarian Reform (51) a committee was formed under the chairmanship of the President of the Board of Directors of the Agriculture Centre to deal with A and B above.

A. Committee for evaluating the performance of the GCMAP (52)

Between December 1975 and May 1976 several meetings were held in Tripoli and Tauorga project in order to investigate the performance of the GCMAP and to report back.

The committee for evaluating the activities of the GCMAP found that the company did not achieve the required progress. On the contrary, at that time it had been found that for example, and most seriously, instead of decreasing the levels of soil salinity in the process of land preparation, about half of the fields experienced increases as measured by electrical conductivity (see also 6.2) Based on these findings it was decided to allow the company a limited period for improvement of its performance. The employment of a new managing team resulted in some improvement but at the meeting of 22nd February 1976 it was found that the company was still not able to fulfil its obligations and they were asked to look for technical support elsewhere. By 10 May, 1976, the decision was taken, on the basis of further improvement, to let the company continue in the project.

B. Evaluation of present and future of the Agricultural Potential of the Project

On 23 November, 1975,[53] the committee met in Tripoli in order to discuss the present and future agronomy, management, economy of the project and the performance of the laboratory. This took place after a study of all available documents, site visits and site consultations. The committee reached the following conclusions -

In the opinion of a number of members of this committee, there should be some modification since:

a. Soil, in general, and on reclamation land in particular, had large inherent heterogeneity i.e. big variations in its properties. For this reason further study, sampling and analysis of soil and and reclamatory cultivation in the project had to be further modified in ways suitable to ground conditions.

b. Actual figures for extracted water discharge varied between 5 and 1.9 m^3/sec. (see pp.63-64). Accordingly this cast some doubts about the final size of the project's irrigable area. Further, there was some difference of opinion about a connection existing between water sources of the spring and of other sources in the area.[54] If, as seems highly probable that JEFLT's statement that there is such a linkage then other regional projects will draw on the same water resources as does Tauorga and this will affect agricultural utilization.

c. Many problems of irrigation and drainage (see pp.212-218) are not unusual in canal systems but the maintenance problem must receive continual attention.

d. The choice of crops and cropping pattern depends not only on local potential but also on the nature of its production and economic framework. Now a number of new possibilities of cropping systems were prepared and submitted by some committee members. The authors presented four different farming types designated as variants A,B, C and D. Each variant was described in detail including proportion of area under different crop, calculation of required labour, working days, price, nutrients, expected production, herd structures etc. They could be summarised as follows:- (55)

A. - Distributed to farmers variant A : Land Settlement Scheme - Project divided into 10 ha. farms for settlers with cropping systems to be later decided.

B. - Centralised farm production unit Fodder production, variant, B : Fodder production for sale. Project land to be under fodder crops, crop production for external sale. Suggested crops - alfalfa (500 ha.), sorghum and soya bean (500 ha.) broad beans (500 ha.) and barley (500 ha.). Here, however, the status of the workers was left open.

Livestock/fodder production (variant C : Agro-industrial unit, half under fodder for milk and meat production and half under fodder for sale. All project land to be devoted to fodder production and livestock with half of produced fodder for selling.

Livestock enterprise (variant D : agro-industrial integrated unit for milk, meat and breeding heifers). All project land to be for livestock. Each of variants B, C, and D is managed as one unit.

Of these four different and new proposals there were three, B,C and D which totally change the project's key objective of creating 300 newly settled farming households. Moreover, B,C and D also were based on unproven assumptions regarding technical and organizational capabilities.

On the other hand some members referred to a 1975 WAKUTI report [56] on alternative types of farm system, all on the basis of distributed small land holdings, and which can be summarised as follows:

(1) Intensive - based on vegetable production.

(2) Mixed - based on crop and livestock husbandry.

(3) Extensive - based on forage and fodder crops and sheep husbandry.

However, the report mentioned that these types should be established on experimental bases in order to assess their suitability. The size of farm and nature of farming should be decided upon in the light of experience.

Nowhere, however, was established the basis on which any final decision was to be taken i.e. on the national or regional need for the products, on the human capabilities available or on ecological land potential.

Special attention was paid to the best method for management of the project, [57] and whether to continue under government operation or distribute what land was ready to the farmers. It was decided unanimously that land was not ready for distribution and, even at the end of reclamation contract (April 1977) it could not be considered ready, and therefore another later evaluation would be necessary. It was recognised that land reclamation projects of this nature usually undergo at least

2 years test-period after completion and therefore further time would be necessary before thinking of land distribution to farmers as planned. Furthermore labourers working in the project would need more training. Therefore the timescale for the project is extended to a length of time during which some of the variables studied at reconnaissance survey level will have changed considerably, something also considered in Chapter 7.

6.7 An evaluation of proposals considered in 6.6

First, it must be said that evaluating the performance of GCMAP was not carried out in any fundamental way. Thus to take a decision whether or not to let the company continue solely on the basis of slight improvement in leaching work was not enough. The ability of the company to implement the projects according to plan as a whole should have been investigated, covering aspects such as management, structure, number of personnel involved and their qualifications, technicians, labourers and machinery number and quality etc. and fulfilment of contract.

Secondly was the matter of the evaluation of the present and future state of the agricultural potential of the project. The proposed measures can be classified as follows -

(i) Curative solution i.e. changing the technical specification, soil sampling and analysing etc.

(ii) Preventive solution i.e. drainage system and irrigation system.

(iii) Steps for the future i.e. springs water discharge, fluctuation control and socio-economical aspects i.e. production, training, labourers etc.

Unfortunately neither the curative nor the preventive solutions could be applied because of the lack of suitable personnel to implement these measures. Apparently the level of worker skills has been ignored, a regrettable oversight in view of the importance of well qualified workers in engineering projects. The introduction of high technology to the programme, in the absence of highly qualified labour, resulted in low efficiency in the use of engineering equipment. Technical inefficiency has not only reduced the impact of engineering work, but has threatened the economic viability of the project, quite apart from the other problems of the project. In particular, overhigh salinity will reduce yields and the quality of crop production.

The low level of labour qualifications, which led to the inefficient deployment of high technology (precise irrigation and drainage maintenance, soil and soil/water management etc.) was therefore the critical factor preventing the realization of the project's objectives. The questions which were not asked but are necessary are (a) should high technology be replaced by technology more appropriate to the low skill levels of the work force or (b) should more attention be paid to producing work skills necessary to make high technology work as efficient as planned?

In general, it is very probable that (b) rather than (a) will be chosen because high technology applied by highly qualified workers will lead to increasing crop production (both in terms of quality and quantity). This is the desired aim of all LDC's in order to fulfil their own consumption requirements. Crop production must increase in proportion to increases in population. In case of exceptional increases in productivity, crop export may be possible and food products may compete on the agricultural commodity market. Furthermore through high technology applied by highly qualified workers, it is possible to achieve the goals of government agricultural planning policy more rapidly and more effectively than if low technology were applied by unqualified workers.

Constraints such as the time available to implementation programmes however make this choice difficult to effect since it takes considerable time to train an unqualified work force to a suitable level, where the gap between worker qualifications and the technological level of the project is the prime factor hampering an agricultural project. Also capital and financial investment is necessary to renew machinery, and other equipment to improve the range of seeds and fertilizers etc., to buy spare parts and to build infrastructure and housing stock suitable for qualified technicians.

The situation within the project under question is one where capital and investment sources are abundant, national labourers are scarce and technicians are not sufficiently highly skilled. European technicians will leave Libya as their contracts finish, and Tunisian and Egyptian immigrant workers and technicians will leave Libya as soon as they save enough money to get married or to build a house or buy a car in their home countries. For this reason attention has to be paid to training of indigenous people in skills necessary to make high technology work at the efficiency levels planned. This policy is strongly recommended but it also implies some type of policy to encourage trained personnel to remain in the project area and not migrate to urban centres.

Should it be difficult to meet the renewal and running costs of high technology (not at the moment a problem in Libya) and if the time necessary to raise skill levels to the standards desired and to retain these skills in the project is so great as to endanger success (and this is a serious possibility in Tauorga), then one must belatedly reconsider the alternative option listed under (a) : should the high technology approach be replaced by technology more appopriate to the low skill levels of the work force. How could this be secured?

First of all the level of qualification in a country or region has to be accurately estimated and according to this estimation plans may be made for type, size and volume of machinery and other equipment required for the project. Methods of cultivation, and marketing processes could be adjusted appropriately.

Secondly, the time scale has to be reviewed in terms of the objectives being sought. A lower even though appropriate level of technological requirement will give different returns over a different time period than would a high skill and high technology programme.

Such an apparently retrograde step is not likely because all LDC's desire to attain the standards of the developed countries and associate these with high technology. Nevertheless it may be necessary,despite the disadvantages listed in Table No. 6.7.1 below :

Approach	Time	Cost per hectare	Quantity & quality of product	International marketing competition
High skill & high technology	y	x	A or B	possible
Low skill levels & appropriate technology	y?	x-?	A-? or B-?	v.doubtful

Some specific situations such as economic and environmental constraints may severely limit the freedom of choice of agricultural policy makers. That is to say, there may be little choice other than to pursue very simple subsistence based agriculture alongside the use of high technology. In this case low skill level and high technology have to be accepted.

But the question is how far can this be built into development planning for this kind of project?

Of course with low skill level + high technology the result will be lower efficiency but this could be acceptable if deliberately planned. The level of reduction in hypothetical efficiency then has to be estimated. What level e.g. 80% or 60%,would critically, negatively affect the project from the point of the economic returns and the level of returns to the farmers? In the long term this will also affect the development of the region. There are several concepts involved here:-

1. Since the project is not functioning at full efficiency the goal will not be secured within the period planned; but might be secured if more time is provided.

2. The government has to decide whether or not the required prolonged time is important; if it does matter then :

3. The government has to supply financial support to help the project achieve its goal within the fixed time.

4. Attention should still be paid to produce the skills in the labour force necessary to make high technology work as efficiently acceptable to any given terms of reference e.g. the saving of imports.

However, as we shall see in Chapter 7, there are always some levels of performance in some critical areas which must be achieved at a critically high efficiency rating otherwise there may be no likelihood of any acceptable outcome.

Conclusion

In considering the difference between the original proposals and the actual and hypothetical implementation of the second phase - stage 2, we have endeavoured so far to identify all the relevant factors and to illustrate how on a micro-scale as well as at general project level the problems which arose. This is important because it can be shown to be relevant, not only to the specific porject under study, but also to most agricultural projects in LDC's., and this we take further in the following chapters.

The decision was taken to build and construct this settlement project according to general policy objectives which were based on the results of the reconnaissance survey and study of the five key factors (Chapter 3) and the four main headings (Chapter 4). Some of these, particularly know-how, technology and technical ability, (both in project establishment and its farming operations) were not considered sufficiently seriously.

Thus, those shortcomings of the second phase - stage 1 which appeared, were mainly due to the incomplete and incorrect execution of this stage (see pp.209-214). These shortcomings were compounded in the second phase - stage 2; and other problems specific to it also arose during the execution of this stage. We also have noted that some problems arose due to inadequate clarity and weighting of the project's objectives, e.g. which was most important, profitable production, or efficient resource exploitation, or the settlement of 300 families.

A greater range of technical problems were encountered than conceived of by the original survey and many problems proved to be more acute than initially expected.

In the following chapters we will attempt to review fundamentally and typologically what has happened in Tauorga by applying various analytical methods, and also to test the validity of such a review by examining some other projects in other countries.

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CHAPTER SEVEN

In chapter 6 the reasons for discrepancies between plan and actuality were individually identified and analysed. In this chapter an attempt is made to review fundamentally and in terms of general principle what has happened in the Tauorga project, first by applying a type of critical path analysis, secondly by applying the concept of the "law of the minimum" and, thirdly, by applying a matrix analysis to the suitability and interdependence of the factors involved in the project development, thus:

7.1 Examination by critical path analysis of the planned design and implementation and the actual design and implementation in order to identify and isolate critical points of convergence and divergence in the flow-paths of operation in planned and actual lead time.

7.2 Liebig's concept of "Law of the minimum": the identification of these critical levels of individual inputs and factors which if not reached will either damage or invalidate the project (assisted by use of 7.1 above).

7.3 Matrix analysis of the suitability and interdependence of the component inputs involved in the project development.

7.1 Examination by critical path analysis of the planned design and implementation and the actual design and implementation in order to identify and isolate critical needs.

In order to be able to carry out a critical path analysis we have first to recognise and identify the various main components of the operational flow paths.

A - Choice of project objectives

1. Statement of objectives (see p.154)
2. Methods and implications of obtaining these objectives (see Chapter 5-2).

B - Planned design and implementation and the actual design and implementation of the project.

1. First phase, study and analysis of the physical and the other factors of production

- planned design - unspecified
- actual design - three times in 1960, 1965 and 1970

2. Second phase

a - Stage 1, construction of project works

- planned design - 2 years, from Nov. 1970 - Nov. 1972
- actual design - more than 3 years, from Nov. 1970 - early 1974

b - Stage 2, land preparation

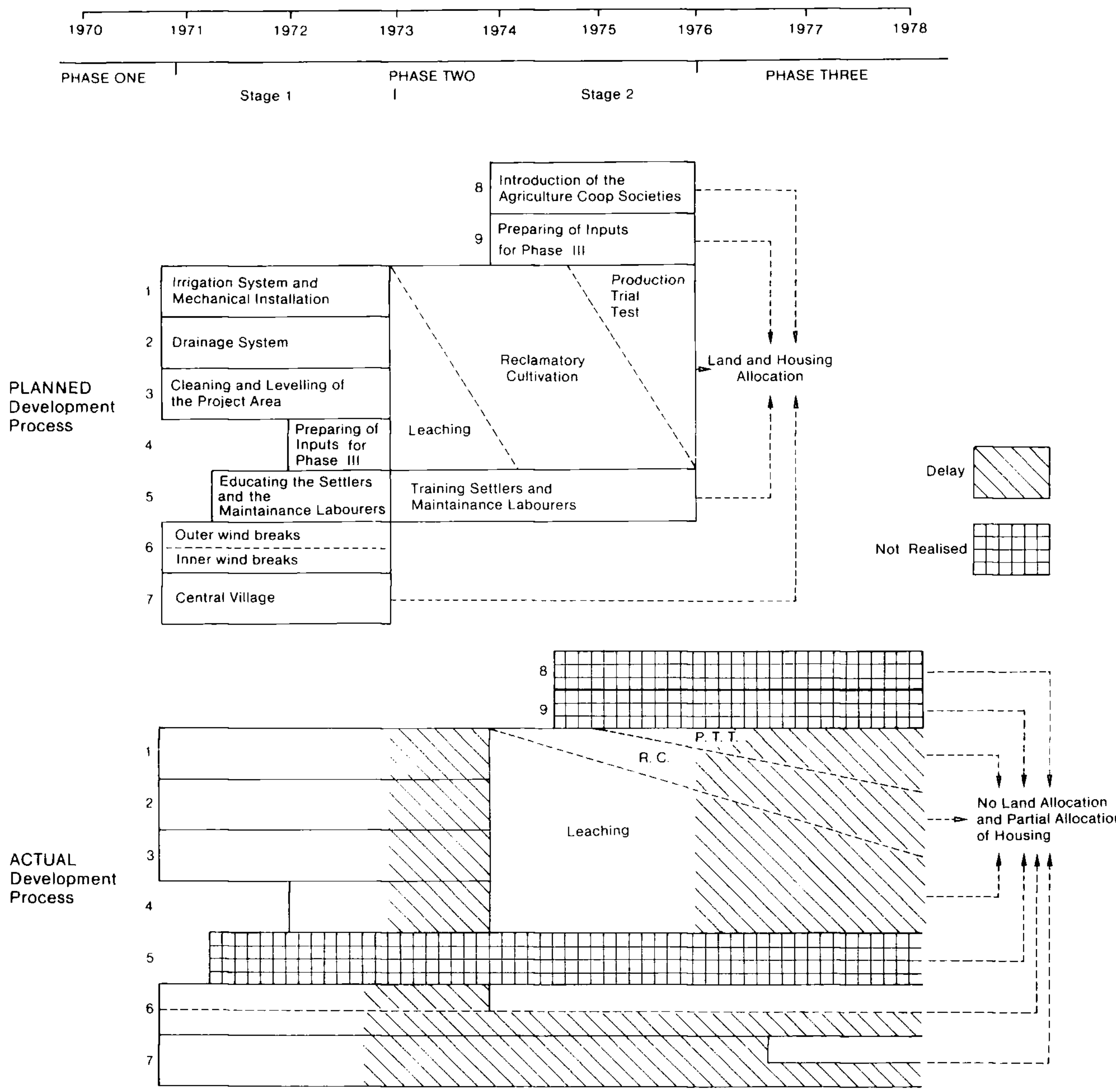
- planned design - 3 years from Nov. 1972 - Nov. 1975
- actual design - ? from early 1974 - ?

3. Production and marketing (allocating of farms and houses)

- planned design - in November 1975
- actual design - ?

The planning and actual progression of inputs and the schedules attained in the development processes are indicated in Fig. No. 7.1.1. These can now be examined by comparing the schedules both of the plan and the performance. It is obvious from Fig. 7.1.1

Fig No 7.1.1 Planned and Actual Progression of the Developing Processes



that the project completion has so far been delayed by more than two years and consequently the objectives are not yet attained. Those items which were delayed and those which have never been started are equally obvious. These delays were caused by the difficulties and problems which faced the project development processes. The socio-economic aspects of real time elapsed during project implementation are of the utmost importance in the determination of the project's future and the discrepancies between planned and actual schedules themselves have critical consequences.

The general plan laid out for the project implementation was based on socio-economic and land potential surveys of the local, regional and national situation as existing during the 1960s (Durham University Survey, August 1960; WAKUTI Survey, Spring 1965; the Egyptian GAUDRL Survey Spring 1970. Based on these studies, the Egyptian Boheria Company redesigned the project in 1970. The production planned for 1975/1976 assumed (as do all projects) that socio-economic changes which occurred during the period between survey and commencement and its completion would not invalidate these objectives. However, any extension of time elapsed between the first decision to develop in Tauorga and project completion is bound to increase the probability that the context of socio-economic circumstances prevailing would change in unforeseen and foreseeable ways.

Since 1960 we can note in Libya, for example, changes in regional and national planning attitudes, a new policy between 1970 and 1973/74 of cutting back on oil production and therefore of oil revenues, and, since 1973/74 the windfall of rapidly rising oil revenues even with some limitation on production. Changes in revenues of this kind are necessarily also accompanied by changes in the availability of capital, in the market demand for project products etc. The actual delay in completion of the project's production phase, by over 2 years at least, has in fact meant that in Libya in which the Tauorga project will have to operate, in total time elapsed from beginning to end will have changed over some 10 years. During such a period the demand effects on quantity and quality of commodities, price and eventually standard of living will have changed. Due to such and other changes it becomes increasingly difficult to predict a successful start for project production as a whole and throws into doubt the absolute and relative viability of the planned individual settler's enterprises. Unless this problem is recognised and reconsidered by the government then the future for commercially viable farming units seems doubtful. A ten year lead-time is not something which many major private enterprises would regard as satisfactory (see also conclusion)

(1) Critical convergence and divergence points in planned and actual lead time

Critical path analysis is essentially a technique of identifying the flow-paths of operations necessary to achieve a particular objective. One can isolate a single main pathway of sequential operation but also it is possible to think of such a main sequence being made up, like a rope, of various strands of sequences. If we examine activity in the latter way we then also see that, over the period involved, different sets of strands are involved at different times. If we also set this critical path analysis in real time (planned and/or actual) we can identify time periods or zones at which any particular set of strands - the component subsidiary paths of the main path - must converge to provide a base from which another set of operations may proceed. These points of convergence are critical in that without them the following sequence, which includes a divergence of another set of component subsidiary paths, cannot occur according to plan. Furthermore, if convergence while not absolutely failing is incomplete or delayed, then a following sequence of operations may not contain all the required strands and divergence may then itself be incomplete or inappropriate.

This is illustrated in Fig. 7.1.2 in which the main flow path of operation is separated into various subsidiary strands. Each of these strands is associated with one particular set of inputs and the convergence and divergence points are identified and critical problems are indicated.

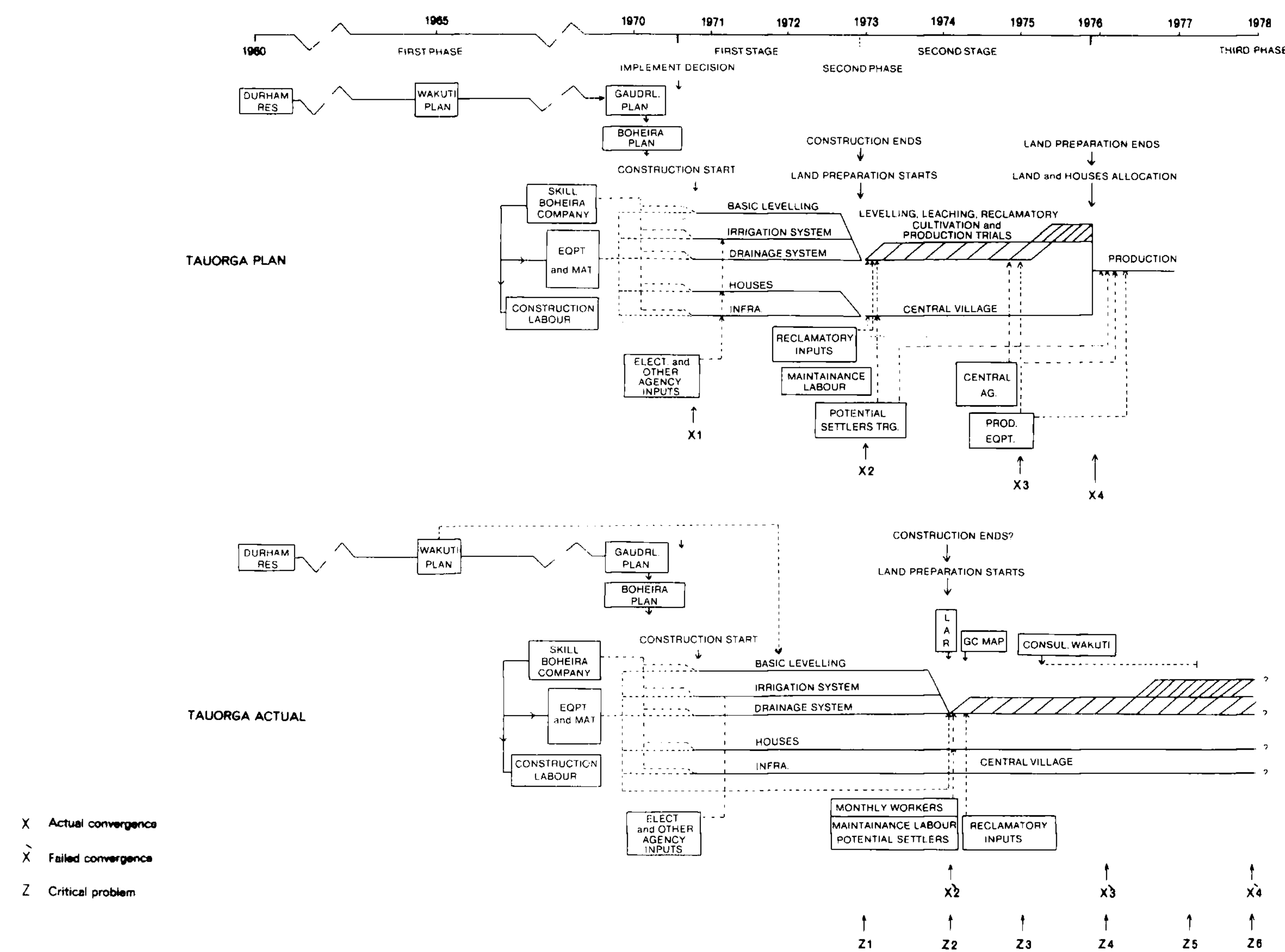
a. The plan - critical convergence points

Figure 7.1.2 shows that once the second policy decision - to construct the project - was taken, after Phase I, preparation of management and the assemblage of skill, labour, equipment and material had to be started to be ready for starting constructing the project by November 1970.

The necessity for these inputs to be on stand-by at this date represents the first convergence point, X1, of input flows without which the construction works (Phase II, First stage) would be impossible .

As construction of the project i.e. the central village, irrigation system, drainage system etc. started, other agency inputs such as electricity and social services must be supplied. The project construction had to be completed on November 1972, since by this date Phase II, Second Stage, the land preparation

Fig No 7.1.2 CRITICAL PATH ANALYSIS



After H. Bowen-Jones

i.e. reclamatory inputs such as machinery, seeds, etc., the maintenance labourers and the potential settlers training and new management etc. must be introduced.

This, therefore, represents the second convergence point X2 since if the construction works were not finished and the land preparation inputs were not ready it would be impossible to start the land preparation activities.

While land preparation (Phase II, Second Stage) including levelling, leaching, reclamatory cultivation and production trial tests, all these requiring specific sequential processes, are under way, the central agencies i.e. the agriculture cooperative society etc, and the production inputs must be prepared and standing by in order to be partially introduced and utilized before November 1975 at which point the Third Phase - production, should have started. This identifies the third convergence point X3, without which production trial testing cannot start. The land preparation had to be finished on November 1975 since at this date a complete introduction and utilization of the central agency, production inputs, trained settlers and maintenance labourers will allow the start of production, involving also land and housing allocation at this date. This represents the fourth convergence point, X4.

This was the plan; what happened in actuality is considered below.

b. Actual - critical convergence points

Indeed all requirements for constructing the project were met by November 1970, and thus this first convergence point was, in fact, met. Unfortunately, construction was not completed by November 1972. This appears as the first critical problem Z1, but, except for the central village, construction was completed in November 1973. However, at this date the settlers and the maintenance labourers were not even identified, housing was not ready, reclamatory inputs were not ordered. Instead, labourers, some of whom it was later assumed might become settlers, were randomly employed as monthly paid labourers; no proper and entire social services had been established in the central village, and the machinery inputs, for example, for land preparation, were not available leading to machinery which was used in the construction being also used for levelling the project area. Thus the second convergence point was not met, $\overline{X2}$, Consequently land preparation requirements were incomplete leading to improper and delayed performance.

Thus, even by November 1978 neither the organisational inputs e.g. the agriculture cooperative society, nor the physical production inputs were introduced. Indeed, they could not have been introduced so long as the land preparation was not completed. Thus the third convergence point was not met, $\overline{X3}$, and a further group of critical problems are indicated. The central village was not completed, settlers were not identified , or trained, no maintenance training had been given to labourers, and land preparation had not been completed. There could be no land or housing allocation and thus the fourth convergence point could not be met, $\overline{X4}$.

Further, the necessary strand components of the Second phase, Stage II was not present i.e. the required divergence following convergence X2 did not occur leading to the appearance of critical problems Z2 - Z6. During this critical period therefore it might be said that the project was out of control.

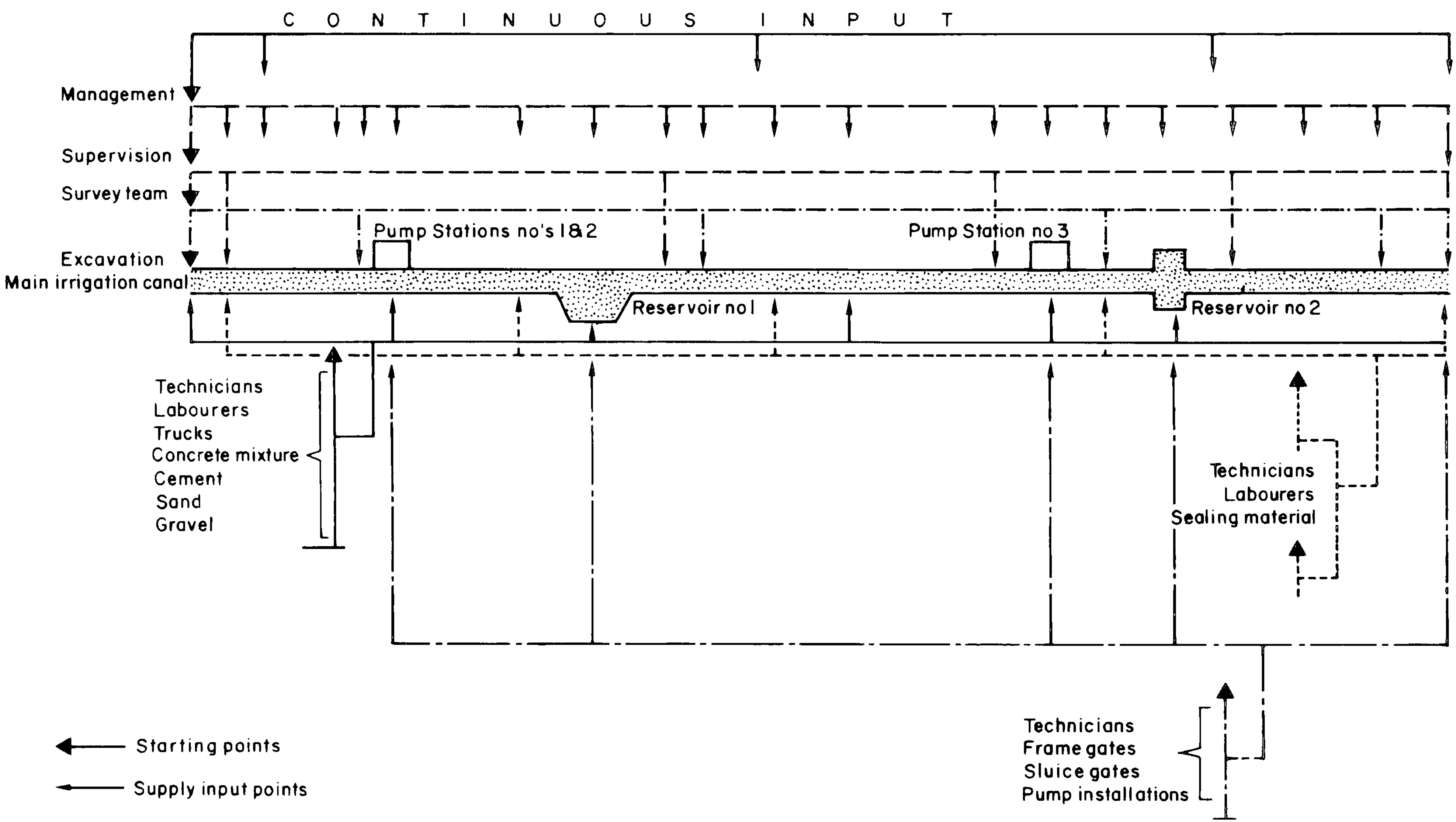
So far we have identified actual and failed convergence points, the consequences of success and failure, and interfaces between stages and phases within the development processes of the project as a whole. There are also other consequences, interfaces and convergence points within each phase or stage. Additionally, there will be interfaces and critical convergence points in each component operation, and here main irrigation canal construction will be taken as an example, as shown in Fig. No. 7.1.3.

Figure 7.1.3 shows that each component operation has an interface with others and there will be necessary convergence points for sets of operations.

As soon as the survey team has started, excavation equipment must be ordered to commence excavation of the canal. As soon as certain areas of surveying and a certain amount of excavation has been completed, labourers, technicians, cement mixture, truck and raw material i.e. cement, sand, gravel must be ready and on stand-by at this point in order to start construction. As excavation in certain areas is completed pouring of concrete may start, while surveying and excavation may be continued in other areas. Management and supervision have to be established as surveying starts, and management has to arrange for the integrated phasing of every operation; supervision, inspection and investigation of all the operations performed have to accompany each operation.

As soon as the irrigation canal, pump stations and reservoirs are constructed then the frame gates and the sluice gates can be positioned at the appropriate points in the system and the pumps may be installed as well. As these are positioned and installed then the sealing material must be ready to be

Fig 7·1·3 MAIN IRRIGATION CANAL CONSTRUCTION AND THE RELEVANT MECHANICAL INSTALLATION



placed by the labourers and technicians in the joints. Thus at certain specific times some operations have to start while others have to be finished. What happened in reality is that the correct inferfacing of operations was not achieved and the planned convergence points were not attained.

Construction work was interrupted, sometimes due to lack of construction material on site on time and sometimes due to financial difficulties of the contractor (see p.211). Pump installation was also delayed due to the late arrival of the technicians from Germany.

However, completion of the construction of the irrigation system to bring water from the spring to the project area critically depended on the intermeshing of each part of the construction processes. The absence of the planned intermeshing resulted firstly in delay and,secondly, in qualitative deficiencies which are best examined separately in 7.2.

7.2 Liebig's concept of "law of the minimum"

The identification of critical levels of individual inputs and factors which if not reached will either damage or invalidate the project.

This task will be approached by applying the concept of Liebig's "Law of the minimum". This law, first formulated in relation to fertiliser application, states that "by the deficiency or absence of one necessary constituent, all others being present, the soil is rendered barren for all those crops to the life of which that one constituent is indispensible". The principle of this approach can be applied to other activities and here is used to ascertain how far can we identify the effect of any particular deficiency in isolation, how far do some cluster factors appear significant and, lastly the degree of criticality of a single factor or a cluster of factors.

Different crucial items could be measured in terms of time and money i.e. period of delay and how much financial return could be obtained if work performance was executed in the right way. It is however difficult to isolate each item in order to know the degree of importance of its component effectiveness. All the project's development processes of construction and soil preparation, reclamatory cultivation and production etc. had to be executed accurately and entirely 100% as the plan requires to allow the project to work to its full capacity. But, often some development processes are not completed entirely or sometimes not at all, what happens then? In an attempt to classify crucial items, here are four different degrees of criticality:

1. <u>Delay</u>

Delay in achieving the project's targets within the original time-scale leads to delayed return from the project and the costs will be more than originally expected. However, the project may still be completed even though late on target approach.

2. <u>Temporary reduction of production</u>

This includes the difficulties or problems which will lead to reduction of production, and may be called temporary because normal production could be achieved by rectification.

However, this implies a temporary reduction in production either in quantity or quality or both of the crops' yield due to e.g. not using machinery to full efficiency, improper irrigation, improper cultivation, poor management etc. Furthermore, some problems such as improper leaching and re-salination will lead to restriction in the range of choice of the crops or varieties, and if the planned settlers' returns are marginal the final objectives may be seriously endangered, that is to say the return might not match the hoped for local, regional or national development.

3. Permanent reduction of production

This includes difficulties and problems which will lead to reduction of production, which can be called permanent because the production will be permanently reduced below that planned due to incomplete construction or improper construction of some of the project components. However, this reduction in production will be permanent because, for instance, technical mistakes which took place during the project construction permanently reduce the efficiency of the project capability. For example, the technical mistakes which Boheira Company made during performing the Second phase - Stage 1, construction, led to some designated land being abandoned and to low efficiency drainage and irrigation systems (see pp.212-214).

Additionally, the technical mistakes caused by poor management, the lack of experience of technicians etc. during the Second phase - Stage 2 led to developing of further sink-holes. Such mistakes had grave and permanent consequences for agricultural operations.

4. Failure of the project

Some items such as lack of capital, the unavailability or unsuitability of settlers to be farmers will lead to project failure. Furthermore, some problems such as resalination, very high ground-water table associated with other problems could lead to failure of the project, either as a whole or in large part.

The Tauorga project is not singular in being hampered with the problems and difficulties mentioned in chapter six. However, we can further analyse the situation by asking the following questions -

Question 1 - are the problems of a general kind i.e. may happen anywhere?

2 - are the problems specific to the local environment?

3 - are the problems specific to less developing countries, i.e. reliance on foreign skill, experience, material construction and equipment?

4 - are the problems due to an inadequate and vague formulation of project objectives?

5 - are the problems due to an inadequate appreciation of -

a. time dynamic?

b. regional setting within national context?

Every problem of the types mentioned above has a different range of negative effect on the project future.

Let us therefore examine separately each of these consequences of degree of criticality in various phases of the project.

(i) <u>Phase 2 - Stage 1, construction</u>

Q.1. Question of problems of general kind:-

<u>Delay</u> - Apart from delay caused by late arrival of the imported construction material and the financial difficulties (see p. 211), the Egyptian Boheira Company was not as capable as expected. The construction period was supposed to be 2 years, but the actual execution, except for the central village, exceeded 3 years.

The central village was not completed but was at least partly finished and this would not entirely hinder the commencement of the next stage.

Permanent reduction of Production:-

1) The technical mistakes which Boheira Company made by using the wrong machinery for levelling operations (see p. 212) led to the abandoning of some djosas (see p. 212) and, in other djosas where the top soil was partly removed, agricultural operations are very difficult to perform and probably will never come up to expectations.

2) Technical mistakes led to frequent breaks of the main irrigation canal as unsuitable soil material was used as embankments for this canal (see p. 212), endangering the agricultural operations.

3) Boheira Company deep ploughed several djosas up to 90 cm in depth and it is believed that this deep ploughing has a hand in developing sink-holes and therefore in the destruction of some land.

4) The improper construction of the drainage system led to improper functioning of the drains and consequently the ground water table level rose.

(ii) Phase 2 - Stage 2.

1. Soil Preparation

Soil preparation opens with the completion of construction work. In this stage the following problems could be identified. This phase started late because of the late end of the completion of the Second phase - Stage 1.

Q.3. Question of problems specific to L.D.C.'s

Delay: The landplaners, which are the proper machine for this project were not available because of import delays and leaching was in turn delayed.

Temporary reduction of production:

The critical nature of the required accurate levelling of land for the proposed irrigation method and for even distribution of water for leaching purposes were not sufficiently appreciated.

Some Djosas are still not cleared of stones (see p. 153)

Q.2. Question of problems specific to local environment - Temporary reduction with the possibility of leading to permanent reduction of production:

As salinity of both the soil and the irrigation water is concerned, one can say:

1. Unless the soil is leached properly associated with proper drainage it can not be used as intended (greater complications than expected), also see 2 below.

2. Given greater problems with continuous rise in the water table, and re-salination then new sink-holes were created, some designated land could not be prepared for cultivation and this reduced the proposed area and eventually the potential return.

3. The frequent breaks in the main irrigation canal, construction defects, exaggerated by nature of e.g. embankment material with high soluble salts content, led to cavitation and the lowering of expected flow capacity in general and increased the risk of critical interruptions in field supply.

3. Reclamatory cultivation

Reclamatory cultivation follows with proper leaching, but since proper leaching could not be achieved in some parts of the project, reclamatory cultivation did not give the expected results.

Furthermore, some properly leached parts of the project could not be maintained.

Q.1 Questions of problems of general kind

Delay:

Problems of delayed arrival of seeds, equipment and fertilizers, etc. enforced the management to alter the planned cropping pattern to another one which was not the best for reclamation (see p.140).

Question of problems specific to L.D.C.'s

Temporary reduction in production

(i) The temporary and inconstant periods of employment of expatriate workers, technicians, administration and engineers clearly reduced the hypothetical efficiency of management which also did not have adequate experience to manage the project and which was different from that responsible during the construction stage.

(ii) The lack of proper maintenance of the project's components i.e. drainage and irrigation canals.

(iii) Bad maintenance of the machinery and the poor performance of the workshop.

(iv) The frequent cuts in electricity supplies adversely affected the project's water pump operation.

(v) The lack of proper water and soil management continued the process of sink-holes formation with a further known loss of land and unknown effects on the watertable.

Q.4. Question of inadequate and vague formation of project objective - Permanent reduction of production

The discharge of the springs on which all water use computations were based, was significantly lower than expected (see pp.244-246) Furthermore, no measures were taken to protect this critical resource of water even after establishing the project. See Chapter 6.4 item Nos. 3-6.

Permanent production reduction or project failure

The division of land into holdings of 10 ha. each does not seem wise and if allocation had been carried out it seems very doubtful whether holdings would have been worked to capacity or even taken up (see pp.236-239). Similarly, the planned education and training of settlers was not carried out to any significant extent, which probably would have had similar effects to the above (see Chapter 6.4 item Nos. 1, 7 and 8).

Q.5. Question of inadequate appreciation of

a - Time dynamic

The internal administrative and political changes which have occurred in Libya since the first plans were drawn up are considerable and some of these have had critical effects on project management and responsibility (see p.231). Earlier (see pp.172-174) we noted changes in agricultural prices and it is also clear that the balance between prices of imported equipment and consumables and Libyan revenue has changed. Equally important have been changes in external relationships, e.g. with Egypt and Tunisia, which have severely affected the availability of expatriate labour. The point here is that any doubt over long-term stability in Libyan internal and external affairs has critical repercussions on any project of this or similar magnitude.

Q5 - b Regional setting in the national context

The specific regional setting required the following:-

1. Adequate number of settlers (see pp.98-99)
2. Desire to be educated and trained in new skills, machinery handling .
3. Compatability with conditions enabling them to stay and be farmers.

The settlers from Tauorga Oasis will still be in Tauorga area as they are shifted to the new farms, so there will be no problems of adapting them to new weather, soil, or new neighbours. Furthermore those settlers will stay close to their tribe, the situation in this project being far easier than such problems faced in Saudi Arabia. However, given a national shortage of labour and the fact that mobility, once encouraged at any scale, is difficult to control, it is dangerous to assume that the new settlers would necessarily have remained in the region. This cannot be tested since, so far, Q2 + Q3 + part of Q1 end the project with no settlers.

Moreover, these and other factors do not stand in isolation. New, poorly trained settlers, with land subject to sink-hole development, at the risk of interruption of water-supplies, and control by a hypothetical cooperative society, might not be the most permanent or productive farmers. Thus these or other cluster of factors such as Q4 or/and Q5-a might drive the project to failure in large part. Again, unless extreme measures are taken to rectify this deteriorating situation the whole project will be subjected to danger.

Lastly, in terms of the national situation, we have to ask, whether Libya with its own special manpower problems can properly supervise and man many different projects (of which Tauorga is only one) simultaneously. The answer as with some other L.D.C's is "probably not".

7.3 Suitability and matrix analysis of the interdependence of the input factors involved in the project development processes

In this section we examine the suitability and the interdependence of the input factors, covering both the planned and real consequences of suitability and interdependence of indigenous and exoganous factors.

Suitability of the input factors

In this analysis the following symbols will be used as an indication of the suitability of the different individual factors influencing the development of the project:-

+ conducive to success
- inhibiting
? possibly inhibiting

a. Planned or hypothetical suitability

We have to assume that the project plan positively proposed was so designed that input factors would be assembled in suitable forms, otherwise positive recommendations for implementation would not have been made. Therefore, Table No. 7.3.1 column 1 should contain input factors, all of which can be identified as conducive to success. In this Chapter the critical path sequence of relating the various input flows has already been discussed and the analysis of factors suitability which follows also assumes that the criticality of path convergences is appreciated in the plan. The examination of the suitability of the input factors will cover all the project development processes:-

TABLE No.7.3.1 Suitability of individual factors influencing the project development

	Planned (1)	Actual (2)	Notes
Phase 2 - Stage 1,construction			
1 Project location	+	+	
2 Capital "fixed"	+	+	
3 Management	+	-/?	
4 Know-how	+	+	
5 Technicians	+	-	
6 Labourers	+	+	
7 Irrigation system	+	-	
8 Drainage system	+	-	
9 Shelter wind-breaks	+	+	
10 Central village	+	+	
Phase 2 - Stage 2,soil Preparation			
11 Capital application and investment	+	+	
12 Climate	+	+	
13 Soil - levelling	+	+/-	
14 - salinity	+	+/-	
15 Water quantity	+	-	
16 quality	+	+	
17 Management	+	-/?	
18 Know-how	+	+	
19 Skilled workers	+	-	
20 Maintenance Labourers Number	+	-	
21 Education	+	(-)	has not taken place
22 Training	+	(-)	" "
23 Future Settlers Number	+	+	
24 Education	+	(-)	has not taken place
25 Training	+	(-)	" "
26 Irrigation processes	+	-/?	
27 Drainage Functioning	+	-	
28 Leaching processes	+	-/?	
29 Reclamatory cultivation	+	+/-	
30 Agro-Technicians	+	+/?	
31 Maintenance of the project	+	-	
3rd phase/production			has not taken place
32 Land Tenure	+	(-)	
33 Agri.Cooperative - advisory	+		
34 - marketing	+		
35 Transport	+		
36 Farm size	+		
37 Family size	+		
38 Farm inputs - Labourers	+	(-)	
39 - Others	+		
40 Farm output - consumption	+		
41 - sale	+	(-)	
42 Farmily income	+	(-)	

Phase 2 - Stage 1, Construction

- Project location: The project area is connected with the main urban centres, i.e. Tripoli and Benghazi of the country by means of the high way. This allows an easy access to the markets. The project location was chosen due to the presence of under-utilised resources of water and cultivable soil.

- Capital, "fixed": Libya, with its oil wealth (see pp.16-17) had no problem in supplying capital to buy and import the necessary machinery, equipment and materials etc., to construct the irrigation and drainage systems, or to build the central village or to plant windbreaks.

- Management: The assumed capability of the Libyans to organize, manage and supervise the construction and building work performed by the imported construction company is doubtful. Ultimately this is important because in any development situation it is the domestic management which claims final responsibility, but:

- Know-how: due to lack of Libyan expertise in such construction work had to be imported from abroad in the form of technologists to act as supervisors, advisors and consultants on behalf of the management, and domestic finance was available for such importation.

- Project construction: There is no Libyan Company having the capability to construct and build this project e.g. irrigation and drainage systems, central village etc. according to the technical specifications which are required by the specific conditions of the project area, but a company from abroad had to be imported for this purpose.

- Technicians and labourers: The number required for construction of this phase could not be covered by indigenous supply neither in quantity or quality, but they have to be imported.

Phase 2 - Stage 2, Soil preparation

- Capital application and investment: All the necessary processes, equipment and materials, e.g. leaching, seeds and fertilizers could be met from governmental expenditure.

- Climate: Climatic data for the project area is only available from the middle of 1976, but from data collected near the project (see pp.48-50) it could be concluded that there will be no major problems as long as this conclusion is supported by effective ameliorative measures.

- Soil levelling: The topography of the area (see pp.57-58) favours agricultural production and allows the application of flood irrigation system and an open drainage system after a slight levelling of the land.

- Soil quality: The soils of the area selected for the project vary in texture and structure and degree of salinity (see pp.51-57). It is assumed that they are capable of supporting cultivation but their behaviour under cultivation will require careful monitoring and management.

- The water quality and quantity: these are adequate (assuming the validity of the background studies) for the recommended cropping pattern. The irrigation (see pp.71-75) and the drainage systems (see pp.78-79) are designed to satisfy the water demands of agricultural production under the given circumstances.

- Management: the ability of the Libyans to organize, manage and supervise the leaching and reclamatory cultivation is doubtful, but the situation will be mitigated by imported know-how.

Knowledge. due to lack of Libyan experts in land reclamation experts from abroad have to be imported to act as technologists on behalf of the management.

- Skilled workers: the number of technicians, drivers and their level of skill etc required in the project could not be met by indigenous people, so some of these have to be imported from abroad.

- Maintenance Labourers: there are sufficient labourers to be employed as maintenance labourers for the agricultural project. This was based on the belief of a sufficiently large pool of labour in the Tauorga region (see pp. 98-103) Properly educated and trained they could keep the project components such as irrigation canals, drains and the central village maintained at the required level to operate continuously.

- Settlers: out of the 8,698 inhabitants of Tauorga region (see p. 99) it was assumed that there are enough families to occupy the 300 farms. Their education at school in the central village and their training in the leaching, irrigation processes and in modern farming would ensure the technical viability of the project.

- Agro-technicians: The required number of agro-technicians to supervise every single agriculture operation on site could not be met indigenously, but they have to be imported from countries such as Egypt, Tunisia and Palestine.

Phase 3 - Production

- Land Tenure: It was hoped that as the settlers became owners of farms they would be changed from semi-nomadic to completely sedentary farmers.

Agriculture cooperative - The agriculture cooperative itself is a complete authority equipped with its own administrators , agricultural machinery, transporting means and subsidized by the government.

Thus this agriculture cooperative will be able to advise farmers, supply inputs, and transport and market the agricultural products for the settlers.

Farm inputs - Labourers: It is assumed that the annual family income would be achieved with 4 full-time labourers, but since family size imples that each unit will probably have two full-time workers, each would have to hire and pay 2 additional labour units.

Farm outputs and family income: The hypothetical annual family income for the 10 ha. farm size, assuming recommended cropping patterns would be applied, would be L.D. 1200 - 1500 (see p.199). This is enough to support the family size (present regional average 8 persons) with necessities, this is a good income, especially as home consumption is supplied free from the farms.

b. Suitability in Reality

The hypothetical assumption that the project plan positively proposed was so designed that input factors would be assembled in suitable forms appeared to be too optimistic and over-estimated. An assessment of the real suitability of these factors are shown in Table No. 7.3.1 column 2.

- Project Location : Remains as in the hypothetical case (see p.282)

- Capital "fixed" : Remains as in the hypothetical case (see p.282).

- Management : The capability of the Libyans to organise, manage and supervise at top-level, project implementation, e.g. the construction and building works performed by the Egyptian Boheira Company proved to be inadequate.

- Know-how : Supervision, advisors and consultants had to be imported to overcome the problem of the lack of experience of the managment. The extent of the influence of management on this item is not clear here but will be apparent in the interdependence analysis

- Technicians and labourers : Technicians and labourers required for construction had to be imported; however it appeared that the capability and experience of this imported labour was lower than hypothesised.

- Project construction : As there is no Libyan Company to build and construct such a project, a company from abroad (see p. 31) had been imported to carry out this project, but this company was guilty of errors of judgement and technical mistakes (see pp.212-214). during the constructing phase e.g. irrigation system, levelling works etc.

- Capital application and investment : Remains as in the hypthetical case (see p. 283).

- Climate : No major problems should have been caused here if precautions were taken e.g. against the ghibli by windbreak planting, but preparations were not well taken and this led to unexpected problems (see p.216).

- Soil levelling : The topography of the project area did not seriously inhibit agricultural land preparation but levelling, required in a few places, was not always adequately carried out (see pp.212 & 219).

- The soil : The assumption was that, with careful preparation, the soil was capable of supporting cultivation. In several areas of the project this has proved false.

- The water quantity and quality : The water quantity is now inadequate for the recommended cropping pattern (see pp.63-64). The irrigation and the drainage systems are designed to satisfy the water demands of the agricultural production under the planned circumstances. However, the frequent breakdown of the main irrigation canal (see p. 214) and the inadequacies of the drains have led to complicated problems

- <u>Management</u> : The ability of the Libyans to organize, manage and supervise the leaching and reclamatory cultivation proved to be inadequate (see pp.222-223).

- <u>Know-how</u> : This item had been imported (see p. 104) to act on behalf of the management in order to overcome the problem of inexperience of the management. It is not clear, in isolation, how far this proved suitable, but becomes clearer when we examine interdependence

- <u>Skilled workers</u> : Agricultural machinery handlers proved to be inexperienced even in applying classical agriculture methods. This problem is now serious as those workers have to deal with saline soil e.g. critical depth ploughing, seeding, levelling, etc.

- <u>Maintenance Labourers</u> :

<u>Number</u> - The number employed is not enough to cope with the required maintenance work.

<u>Education and Training</u> - Has not taken place so far and thus the suitability of labourers and potential farmers can not be examined. The likelihood is that this item would have proved deficient.

- <u>Settlers</u> :

<u>Number</u> - Remains as in the hypothetical case (see p.284)

<u>Education and Training</u> - Has not taken place as planned and thus their suitability could not be examined.

- Agro-technicians : The required number of agro-technicians for the project was provided, but some of them proved lacking in practical experience.

Phase 3 - Production

- Land tenure : Although no allocation of farms for the settlers has so far taken place and thus its suitability cannot be examined, it can be predicted that this item will create problems in the long run (see pp. 112-114).

- Agro-Cooperative :

Advisory and Marketing - have not been introduced to the project yet and thus its real suitability in the project could not be examined.

- Transport : Farm size; Family size; Farm inputs; labourers and others; Farm output, consumption, sale; and Family income - have not yet taken place and thus their real suitability could not be examined. However the earlier analysis, Chapter five - part two, of required farm inputs of labour (pp.194-198) (see also pp.94-103) and farm outputs and family income (pp198-201) suggests that here again there would have been deficiencies

Interdependence of the input Factors

We have examined above the input factors separately and individually in terms of their planned and actual suitability. Already we have seen that they cannot only be treated as isolates.

The complex interaction between physical and other factors of production, together with certain characteristics of the farmers themselves, help determine the range of possible forms of development.

The suitability of the individual development factors do not show the complete picture of prospects of the project. Attention here will then be focussed on their interdependence and their resulting impact as a development group. The interdependence of all these individual factors and their contribution towards agricultural development show why in each case success or failure took place.

The influence of these factors, now considered as interdependent components in the "development group", is decided by their clustered suitability for agricultural development in a whole matrix. Some key problems can be generally identified.

A - One of the critical factors affecting the planning of agricultural systems is the unpredictably sensitive nature of the land factor i.e. the environmental resources to be exploited.

B - Further complications arise from the not completely predictable expected responses of settlers to their new planned environment i.e. their knowledge of new developments in farming, and their willingness to accept these innovations as against an inclination to revert to traditional farming systems as their fathers and grandfathers had done before them.

From a study of the environmental inputs to the agricultural system at Tauorga, as well as analysis of the characteristics of future settlers (i.e. semi nomadic peoples practicing traditional farming and handicrafts (see pp.39-41), one can but feel pessimistic about the prospects of the project achieving its objectives. This because the operation of the project and the type of farming required in this sensitive environment would require great technical and attitudinal changes in the workers concerned.

C - The constraints imposed by the physical environment can be offset to some extent by increasing the level of capital investment in the project and through careful management and training of the operatives. These could mitigate against the negative influence of the natural endowment of the area. Thus:-

1. (A above), capital will provide equipment and machinery for the construction of irrigation systems which are climatically necessary and designed to make leaching of the saline soil possible; thus capital investment can mitigate the severity of soil salinity. It is also true that the virgin soil of this arid area can be improved by the application of fertilizers.

Thus the land might become capable of supporting profitable cultivation. Even the harmful effects of the strong desert wind, Ghibli (see p. 49), can be slightly counteracted by developing wind breaks and shelters.

2. The conditions affecting the allocation of land to settlers (see pp.43-44) deal with future settlers' education and training, as well as with farm and project maintenance and, if met, would result in farming success.

3. In addition, an agricultural co-operative was planned to be introduced at the beginning of Stage III (Production) of the project and this would link points 1 and 2 above.

Consideration of these positive measures which could be taken to improve the prospects of the project, lead perhaps to an optimistic view of the eventual proper utilisation of the considerable potential of the Tauorga project.

In Figs. 7.3.1 - 7.3.5 we use a matrix technique to illustrate in relative terms, the degrees of interdependence between factors, utilising the following value symbols -

\+ Positive dominant linkage; means improvement of agriculture development, suitable.

- Negative dominant linkage; means retardation or prevention of agriculture development, unsuitable.

o Neutral dominant linkage; means no influence.

? Possibly negative dominant linkage; means uncertain, but more likely unsuitable.

Blank entry nil input; means this factor has not applied so far.

An example is given below for each case:-

Where the dominant factor had an improvement influence on the construction or operation of any secondary factor this is indicated by a positive sign (+) e.g. the result of interdependence of the supply, the fixed capital and the construction of the irrigation or drainage systems.

Where the dominant factor had an adverse influence on the construction or operation of any secondary factor this is indicated by a negative sign (-) e.g. the result of interdependence between poor technical supervision of heavy machinery and the misuse of the equipment.

Where the dominant factor had no influence on the construction or operation of any secondary factor this is indicated by a neutral sign (o) e.g. the interdependence between the workshop and climate is almost zero.

Where the dominant factor had an uncertain influence on the operation of any secondary factor this is indicated by an uncertainty sign (?) e.g. the result of interdependence of water quantity with the leaching and reclamatory cultivation processes.

Where the dominant factor had not been applied yet, then the interdependence influence on the secondary factor is not known and will be indicated by a blank sign.

a. Planned or hypothetical interdependence

(i) Second phase - Stage 1, construction

1. Capital "fixed" : Libya with its large oil revenue can afford (see pp.16-17) the buying of the (6) required heavy machinery,

equipment, tools and construction materials to build the (7) irrigation system, (8) drainage system and the (11) central village and to plant the (10) wind breaks according to the specific conditions of the project area.

2. Management : Imported know-how WAKUTI (see p.31), was brought in to act on behalf of the Libyan management as advisers and consultants to organize the (4) technicians, (5) labourers, (6) heavy machinery and the (9) earth works and to manage the construction of the project's components e.g. (7) irrigation system, (8) drainage system, (10) outer wind breaks and (11) central village.

4. Technicians and 5. Labourers : Since there is no Libyan Company having the capability to operate the (6) heavy machinery for carrying out the (9) earth works and the construction of the (7) irrigation system, (8) drainage system the (11) central village by the (4) technicians and the (3) labourers and plantation of the (10) wind breaks, given the abundant Libyan (1) capital,the construction Company, Boheira, was imported to build and construct this project according to the technical specification. Fig. No. 7.3.1 shows these consequences.

(ii) Second phase - Stage 2, soil preparation

1. Capital application and investment : The Libyan government has no problems in financing the supply of all items for the project's soil preparation, such as the required agricultural machinery for (3) soil levelling and for the (20) reclamatory cultivation with the necessary seeds, fertilizers etc. and planting of the (21) inner wind breaks. Also it is not difficult to pay all wages for the (7) management, (8) know-how, (9) skilled workers (10) maintenance labourers, (13) future settlers* and

* Only during this stage

FIG. NO. 7.3.1 Hypothetical Interdependence of input factors Phase Two-Stage 1

Reality	Secondary	Capital "Fixed"	Management	Know how	Technicians	Labourers	Heavy Mach-inery	Irrigation system	Drainage system	Earthworks	Outer wind breaks	Central village
Dominant		1	2	3	4	5	6	7	8	9	10	11
Capital "Fixed"	1		+	+	+	+	+	+	+	+	+	+
Management	2	o		o	+	+	o	+	+	+	+	+
Know-how	3	o	+		+	o	o	+	+	+	+	+
Technicians	4	o	o	o		+	+	+	+	+	o	+
Labourers	5	o	o	o	o		o	+	+	o	+	+
Heavy machinery	6	o	o	o	o	o		+	+	+	o	+
Irrigation system	7	o	o	o	o	o	o		o	o	o	o
Drainage system	8	o	o	o	o	o	o	o		o	o	o
Earth works	9	o	o	o	o	o	o	+	+		o	o
Outer wind breaks	10	o	o	o	o	o	o	o	o	o		o
Central village	11	o	o	o	o	o	o	o	o	o	o	

(19) agro-technicians; and to supply the necessary elements for (11 and 14) education and (12 and 15) training. Furthermore there is no problem of supplying and providing an equipped (18) workshop and to supply the necessary cost of keeping the project's components maintained.

2. Climate : This semi arid climate (see pp.48-50) will adversely affect the (4) soil salinity which consequently affect the (20) reclamatory cultivation. But the (7) management supported by the (8) know-how, the (5) water quantity and to some extent the outer wind breaks and the (21) internal wind breaks will mitigate the negativity of the climate.

3. Soil levelling : Levelling is required in order to make flood irrigation either for the (17) irrigation production or for (16) leaching. Thus accurate levelling of the soil which will be carried out by the (9) skilled workers will guarantee an even distribution of water and the application of the right quantity of water which will affect positively the (4) soil salinity and the (20) reclamatory cultivation and the production phase.

4. Soil salinity : The soils of the area selected for the project are variable in texture, structure (see App-B1&B3) and degree of salinity (see App-B1); but the (5) quantity and the (6) quality of the irrigation water are such that by the (17) leaching and the (16) irrigation a decrease in salinity and thus an increase in the improvement of the soil for the (20) reclamatory cultivation and for agricultural production can be expected; the (11) educated and (12) trained settlers/labourers and (22) maintenance will make this expectation possible.

5. Water quantity and 6. Water quality : The water quantity

and quality are adequate for leaching, for decreasing the (4) soil salinity and for the recommended cropping pattern, the irrigation (see p 71-75) and the drainage systems (see pp.78-79) are designed to satisfy the water demands of agricultural production under the given circumstances.

7. Management : The low capability of the Libyan management to manage the (3) soil levelling to be carried out by the imported (9) skilled workers in order to make application of water of (16) irrigation and (17) leaching processes possible is doubtful. Proper experience of the management in controlling the (4) soil salinity, organizing the (18) workshop, supervising the (20) reclamatory cultivation performed by the (19) agro-technicians and to keep the (22) project's components maintained are also doubtful. But the imported (8) know-how (see p. 33) will act as advisory and consultants service (see p.109) on the above mentioned items for the management behalf and thus these problems could be overcome.

7. Skilled workers : Given accurate (3) soil levelling to be carried out by ~~the~~ skilled labourers, planned by (7) the management, (8) the know-how and supervised by (19) agro-technicians will guarantee proper distribution of water for (16) leaching processes which consequently will help (4) soil salinity to be decreased. (17) irrigation processes and the accurate application of the agricultural machineries for seeding, fertilizing and ploughing under of green manure etc. will encourage proper (20) reclamatory cultivation which will help improve the soil structure.

10. Maintenance Labourers : An adequate number was assumed to exist in the Tauorga region (see pp.98-103). Their (11) education at the school in the central village will guarantee, at least,

that they will be able to deal with figures, and (12) their training by the maintenance team's foreman on the repairing and maintenance work will keep the (22) maintenance of irrigation, drainage systems and central village at the required standard to operate continuously and thus the (16) irrigation and the (17) leaching processes will not be interrupted which will lead to reasonably good (20) reclamatory cultivation.

13. Future settlers : Out of the 1347 families in Tauorga region (see p. 99) there are enough families to occupy the 300 farms; their (14) education at school in the central village will enable them to deal with figures, to use book keeping and to understand modern farming; their (15) training by the (21) agro-technicians in the modern techniques of farming will enable them to execute the (16) leaching and (17) irrigation processes and promote the progress of the project.

16. Leaching and 17. Irrigation processes : With accurate (3) soil levelling by the (9) skilled workers which will make even distribution of water possible, a proper control of the water quantities either for leaching purposes or for the (20) reclamatory cultivation by the (15) trained (14) educated settlers, and proper maintenance of the irrigation and drainage systems by the maintenance team will guarantee a satisfactory water use for leaching and irrigation.

18. Workshop : As long as it is equipped with the required apparatus, tools, qualified staff and agriculture machinery operated by the (9) skilled workers, the workshop will be capable of keeping the project machinery in good condition to be used for carrying out the agricultural operations. Thus the (16) leaching processes, (17) irrigation processes, (19) agro-technicians and (22) maintenance of irrigation, drainage systems etc. will not be hindered.

FIG. NO. 7.3.2

Hypothetical Interdependence of Phase Two - Stage 2

Dominant	Secondary	Capital application and investment 1	Climate 2	Soil levelling 3	Soil Salinity 4	Water quantity 5	Water quality 6	Management 7	Know-how 8	Skilled Workers 9	Maintenance labourers - Number 10	- Education 11	- Training 12	Future settlers - Number 13	- Education 14	- Training 15	Leaching processes 16	Irrigation processes 17	Workshop 18	Agro-Technicians 19	Reclamatory cult. 20	Inner wind breaks 21	Maintenance of irrigation, drainage 22
Capital application and investment	1		o	+	+	o	o	o	+	+	+	+	+	o	+	+	+	+	+	+	+	+	+
Climate	2	o		o	+	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	+	+	+
Soil levelling	3	+	o		+	+	o	o	o	o	o	o	o	o	o	o	+	+	o	o	+	o	o
Soil Salinity	4	+	o	o		+	+	o	o	o	o	o	o	o	o	o	o	o	o	o	+	o	o
Water quantity	5	o	o	o	+		o	o	o	o	o	o	o	o	o	o	+	+	o	o	+	+	o
quality	6	o	o	o	+	o		o	o	o	o	o	o	o	o	o	o	o	o	o	+	+	o
Management	7	o	o	+	+	o	o		o	+	+	+	+	o	+	+	+	+	+	+	+	+	+
Know-how	8	o	o	+	+	o	o	+		+	o	o	o	o	o	o	+	+	+	+	+	+	+
Skilled workers	9	o	o	+	+	o	o	o	o		o	o	o	o	o	+	+	+	+	o	+	o	o
Maintenance labourers No.	10	o	o	o	o	o	o	o	o	o		o	o	o	o	o	+	+	o	o	+	o	+
- Education	11	o	o	o	o	o	o	o	o	o	o		+	o	o	o	+	+	o	o	o	o	+
- Training	12	o	o	o	o	o	o	o	o	o	o	+		o	o	o	+	+	o	o	o	o	+
Future settlers No.	13	o	o	o	o	o	o	o	o	o	o	o	o		o	o	+	+	o	o	+	+	o
Education	14	o	o	o	+	o	o	o	o	o	o	o	o	o		+	+	+	o	o	+	+	o
Training	15	o	o	o	+	o	o	o	o	o	o	o	o	o	+		+	+	o	o	+	+	o
Leaching processes	16	+	o	+	+	+	o	o	o	o	o	o	o	o	o	o		+	o	o	+	o	o
Irrigation processes	17	+	o	+	+	+	o	o	o	o	o	o	o	o	o	o	o		o	o	+	+	o
Workshop	18	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	+	+		o	+	o	+
Agro-Technicians	19	o	o	+	+	o	o	o	o	+	o	o	o	o	o	+	+	+	o		+	+	o
Reclamatory cultivation	20	+	o	o	+	+	o	o	o	o	o	o	o	o	o	o	o	o	+	o		o	o
Inner wind-breaks	21	o	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o
Maint. of irrig, drainage system	22	+	o	o	+	+	o	o	o	o	o	o	o	o	o	o	+	+	o	o	+	+	

19. Agro-technicians : These have to train the (13) settlers and to supervise the performing of (3) soil levelling, controlling the (4) soil salinity, the (16) leaching the (17) irrigation processes and every single operation of the (20) reclamatory cultivation (see pp.129-153). This wide requirement will create initial difficulties, but will be overcome after the (19) agro-technicians gain experience at the site and by proper (7) management supported by (8) know-how.

20. Reclamatory cultivation : With proper (7) management supported with (8) know-how, proper control of the (4) soil salinity by the (19) agro-technicians, proper (3) soil levelling by qualified (9) skilled workers, arrival of the imported seed, fertilizers, machinery etc. at the right time, proper (16) irrigation and (17), leaching and good performance of (18) workshop. The reclamatory cultivation will indeed improve the soil structure which eventually will lead to an increase of the agricultural production, Fig. No. 7.3.2 shows these consequences.

(iii) Third phase - production phase

1. Project location : The highway allows easy (15) transport to the markets either for freighting the farm outputs for (17) selling or supplying the project with farm inputs. This easy access to the markets will positively affect the (18) family income.

2. Land tenure : Land (3) will be allocated to the settlers and thus they become owners of farms in the project; with (9) residence provided in the central village, which also contains all the (8) necessary services and with a realistic (18) family income from the farm the life will be attractive for those settlers and thus a settled community will be formed in this region.

3. Land allocation : The project area which will be divided into 300 farms, 10 ha. for each family guarantee that each farm is

located in a position where transportation of inputs and outputs access is possible and the (18) family income from the (10) farm size is enough to match the family requirements.

4. Agriculture cooperative : Will act as (4) an advisory service for the settlers supplying them with up-to-date farming information, supplying them with inputs such as machinery, seeds and fertilizers etc. at a reduced price and marketing their agricultural products.

Furthermore, through the agri-coop, the settlers will be entitled for free loan interest (see p.20-22) Such facilities will encourage the settlers towards greater agricultural productivity, which means more (18) income from the farms.

8. Central village : This is the place of (9) residence and the (8) social services (see pp.203-205) for the 300 families and the operative staff in the project. These residences and social services together with (18) realistic income from the farm will mean a far better life compared with the living conditions in the oasis. This will be a remarkable step towards the creation of a viable and prosperous settlement. Furthermore the agricultural services in the central village such as the (4) agri-coop administration, the workshop, the warehouse etc. (see pp.122-123) will encourage agriculture production in the project.

10. Farm size : The average plot of 10 ha. will be run by the family, (average family includes 8 persons). Each family will most probably have only two full time labourers, but from the (13) available labourers, two labourers have to be hired. However, the resulting expenses would not be so great as to threaten the family income.

16. Farm outputs : The outputs either for (16) consumption or for (17) sale is based on an effective soil preparation (leaching

FIG.No. 7.3.3. Hypothetical Interdependence of Phase Three

	Secondary	Project Loc.	Land Tenure	Land alloc.	Agro. Coop - Advisory	- Marketing	- Machinery	- Fertilizers seeds, chemicals	Cent. village - Services	- Residence	Farms - Size	- Location	Family size	Farm inputs - labourers	- Others	Transport	Farm outputs - consumption	- Sale	- Family income
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Project Location	1		o	o	o	+	o	o	o	o	o	o	o	o	+	+	o	+	+
Land Tenure	2	o		o	o	o	o	o	o	o	+	o	o	o	o	o	o	o	+
Land Allocation	3	o	o		o	o	o	o	o	o	+	+	o	+	+	o	o	o	+
Agro Coop - Advisory	4	o	o	o		+	+	+	o	o	o	o	o	o	+	o	o	+	+
- Marketing	5	o	o	o	o		o	o	o	o	o	o	o	o	+	o	o	+	+
- Machinery	6	o	o	o	o	o		+	o	o	o	o	o	+	+	o	o	o	+
Fertilizers, seeds etc.	7	o	o	o	o	o	o		o	o	o	o	o	+	+	o	o	+	+
Central vill. -serv.	8	o	o	o	o	o	o	o		+	o	o	o	o	+	o	o	+	+
Residence	9	o	o	o	o	o	o	o	o		o	o	o	o	+	+	o	o	+
Farms-size	10	o	o	o	o	o	o	o	o	o		o	o	o	+	+	o	o	+
-location	11	o	o	+	o	+	o	o	o	o	+		o	o	+	+	o	+	+
Family size	12	o	+	o	o	o	o	o	o	o	+	o		+	o	o	+	o	+
Farm inputs-lab.	13	o	o	o	o	o	+	+	o	o	o	o	o		+	o	o	o	+
-Others	14	o	o	o	o	o	o	o	o	o	o	+	o	o		o	o	o	+
Transport	15	+	o	+	o	+	+	+	+	o	+	+	o	o	+		o	+	+
Farm outputs-Cons.	16	o	o	o	o	+	o	o	o	o	o	o	o	o	o	o		+	+
-Sale	17	o	o	o	o	+	o	o	o	o	o	o	o	o	o	+	o		+
Family income	18	o	o	o	o	o	o	o	+	+	o	o	o	o	o	+	o	o	

and reclamatory cultivation and an effective agricultural production; The facilities supplied by the agri-coop (4, 5, 6) etc. the (15) transportation and the favourable marketing situation (see pp.165-168) would result in a good (18) family income.

Fig. No. 7.3.3 shows these consequences.

b. Interdependence of the input factors In Reality

This sensitive project has its natural problems and therefore must be treated very carefully because any slight mistake will result in major problems.

Here the result of interdependence of the development factors are shown separately in Fig. Nos. 7.3.4 & 7.3.5.

(i) Second phase, Stage 1, construction

1. Capital "fixed": No problems of financial backing arise here during the construction of the project components except for some delays in contractors' payments. On balance this remains as in the hypothetical case.

3. Know-how : Although the know-how was imported from W. Germany, WAKUTI KG, in order to overcome the (3) management problems of organizing, managing and supervising this construction phase, nevertheless, shortcomings appeared in the construction of the (7) irrigation system, (8) drainage system, (9) earth works and (10) central village(see pp.212-214). The question arises, how to explain the know-how's (+) positive dominant linkage as it is interdependent with the construction items which failed. From observation it appears that the application of know-how to the project was ultimately the responsibility of inexperienced local managers who represented the Libyan government. The advisory,

FIG NO. 7.3.4

Reality Interdependence of Phase Two - Stage 1

Reality	Secondary	Capital"Fixed"	Management	Know how	Technicians	Labourers	Heavy Mach-inery	Irrigation system	Drainage system	Earthworks	Outer wind breaks	Central village
Dominant		1	2	3	4	5	6	7	8	9	10	11
Capital 'Fixed"	1		+	+	+	+	+	+	+	+	+	+
Management	2	o		o	+	+	o	-	-	-	+	-
Know-how	3	o	+		+	o	o	+	+	-	+	+
Technicians	4	o	o	o		+	-	-	-	-	o	-
Labourers	5	o	o	o	o		o	-	+	o	+	+
Heavy machinery	6	o	o	o	o	o		+	+	-	o	+
Irrigation system	7	o	o	o	o	o	o		o	o	o	o
Drainage system	8	o	o	o	o	o	o	o		o	o	o
Earth works	9	o	o	o	o	o	o	-	-		o	o
Outer wind breaks	10	o	o	o	o	o	o	o	o	o		o
Central village	11	o	o	o	o	o	o	o	o	o	o	

supervising and consulting foreign specialists who provided the know-how were finally subordinate to Libyan management and thus the actual working decisions remained inescapably in inexperienced local hands.

4. Technicians and 5. Labourers : The imported technicians proved to be unable to execute the required construction processes properly. Their misuse of the (6) heavy machinery led to improper construction of (9) earth works causing the deterioration of arable land and its exclusion from cultivation (see p 212) Bad earthworks were negatively reflected on (7) irrigation system construction (see p.212); also improper compaction at the sides of the (8) drains has led to serious problems (see p 216) as well as to slight problems in the (11) central village.

The imported company proved to be unable to construct the project according to the technical specification and had made several technical mistakes (see pp.212-214) during the construction of the project's components. Furthermore this company did not manage to construct the project within the scheduled time Fig. No. 7.3.4 shows the consequences.

(ii) Second phase, Stage 2, soil preparation

1. Capital application and investment : No financial problems arose but there were delays in importing and in supplying all items for the project's soil preparation. These included the required agricultural machinery for (3) soil levelling and for the (20) reclamatory cultivation and the necessary seeds, fertilizers etc. (see pp.228-230) and plantation of (21) inner wind breaks. Also no problems arose in paying the wages for the (7) management staff, (8) know-how, (9) skilled workers, (10)

maintenance labourers, (3) future settlers and (19) agro-technicians. The providing of the necessary elements for (11 and 14) education and (12 and 15) training did not take place, but not because of lack of capital. Furthermore there was no problem in supplying and providing an equipped (18) workshop and to supply the necessary cost of keeping the project's components maintained.

2. <u>Climate</u> : There could be no major climatic problems, but through (7) poor management such as, in this context, not ploughing the soil at the right time together with a high water table (see pp.216-217) resulting in re-salination phenomena. This adversely affected the (4) soil salinity which consequently affects the (20) reclamatory cultivation. The (21) inner and the outer wind breaks proved inadequate safeguards against the ghibli.

3. <u>Soil levelling</u> : As the flood method either for (16) leaching or (17) irrigation purposes had to be applied, a very accurate levelling of the soil is required, but this task could not adequately be performed by (9) the skilled workers and thus even distribution and application of the right quantity of water could not be guaranteed. As this coincided with (7) bad management the (4) soil salinity and consequently (20) reclamatory cultivation were negatively affected and of course poor expectations for the production phase are predicted.

4. <u>Soil salinity</u> : The degree of salinity in the soil of the area selected for the project could not be decreased as planned (see pp.152-153). (16) leaching (see pp.215-216) and (17) irrigation processes were not performed properly and always the breakdown coincided with (22) bad maintenance, thus the improvement of the soil for (20) reclamatory cultivation and for agriculture production could not be obtained.

5. Water quantity : The lower available water quantity (see pp.63-64) will not be adequate for leaching to decrease (4) soil salinity and for the recommended cropping pattern The irrigation and the drainage systems are not well enough constructed to satisfy the water demands of agricultural production under the given circumstances; the frequent breaks of the main irrigation canal (see p.214) and the non-functioning of the drains proved that.

7. Management : Although (8) know-how was imported to act as advisors and consultants on behalf of the management, most of the problems and difficulties to be avoided remained as barriers. Thus (3) soil levelling and (4) soil salinity could not be properly controlled. Also due to bad management of water the soil/water relationship (16) leaching and (17) irrigation processes could not be performed properly. Furthermore, the management did not carry out the planned educational and training programmes for (10) maintenance labourers and (13) future settlers. These negatively reflected on the soil and on (20) reclamatory cultivation. Managing, organizing and supervising of operations in the project called for experienced management, but the frequent changes in management destroyed the chance of gaining experience. Failure to appoint people with right skills to appropriate positions led to bad management of the project.

9. Skilled labourers : The skilled workers were in fact incapable of carrying out (3) soil levelling properly which made (16) leaching and (17) irrigation processes inside the fields very difficult and negatively affected (4) soil salinity. They were unable to carry out the agriculture operations properly such as ploughing, earth embankments, seeding, fertilising and ploughing under etc. and they were unable to instruct (13) future settlers in technical matters. Furthermore they were unable to

keep the drains maintained. These problems negatively reflected on (20) reclamatory cultivation.

10. Maintenance Labourers : The number of maintenance labourers (see pp.225-227)employed were not sufficient, a management responsibility (7) to keep (22) maintenance of the irrigation and drainage systems in order. Thus (16) leaching and (17) irrigation processes were interrupted which negatively influenced (20) reclamatory cultivation.

11. Education and 12. Training did not take place and thus their influence could not be examined.

13. Future settlers* : It is true that there are enough families to occupy the 300 farms (see p 99), but so far the proposed 300 families are not chosen** because neither the central village nor the reclaimed land were ready to be allocated.

14. Education did not take place and thus its influence could not be examined.

15. Training was minimal and (~~20~~ 19) agro-technicians were unable to train settlers in modern farming and proper (16) leaching and (17) irrigation operation inside the fields.

16. Leaching and (17) Irrigation processes : Leaching and (20) reclamatory cultivation processes were started in the project to prepare the soil for the production phase, but (9) skilled workers could not perform an accurate (3) soil levelling. Simultaneously, some future settlers (13) and (10) maintenance labourers were introduced to the project. These were supposed to be well (11 and 14) educated and (12 and 15) trained, but in fact had very limited experience of modern farming and were poorly educated. The result was that sluice gates were left open, the amount of water applied to the fields varied greatly from the quantities

* Future settlers : to be introduced to the project as monthly labourers paid by GCMAP.

** Only 100 families are living in the central village now.

prescribed, the timing of application of irrigation water was irregular, etc. The combined results of these mistakes were soil erosion, increased (4) soil salinity and the (5) waste of irrigation water. (16) Leaching processes have to be performed by (13) future settlers who had never done it before, keeping in mind inaccurate (3) soil levelling which made even distribution of water impossible (see p.219). Thus the amount of water applied was sometimes too small and sometimes water was allowed to flow in an uncontrolled fashion into the fields (see p.215). Drains which were supposed to carry away the salty water did not function properly because of inadequate and improper (22) maintenance (see p.216) by (10) maintenance labourers and due to application of the wrong machinery caused by (7) unwise management and through lack of experience on the part of (9) skilled workers. This eventually led to a rising water table (see p.216), re-salination (see p.216) and the development of sink-holes (see pp.217-218) which hindered the leaching processes, (20) reclamatory cultivation, slowed down progress in the project as a whole and the capacity of the land for supporting cultivation was reduced.

18. Workshop : The poor performance of the workshop (see pp.219-220) could be attributed to the fact that it is not operated by an entirely qualified team; the bad use of the agricultural machinery by (9) skilled workers and poor (7) management. Thus the condition of machinery (see Table 5-1.3.5) became poor and sometimes the required machines were not ready at need. Consequently (16) leaching and (17) irrigation processes were interrupted, (20) reclamatory cultivation was not as it should be (see pp.214-224) and (22) maintenance of the project components were difficult to perform with the absence of the right machines.

19. Agro-technicians : They proved unable to show (13) future settlers and (9) skilled workers how to adjust and apply the machinery. They were unable to supervise the performing of (3) soil levelling and controlling the (4) soil salinity. (16) Leaching and (17) irrigation process were just as bad and as a result of that the (20) reclamatory cultivation could not be performed, It was very clear that the agro-technicians have several different duties and a remarkable amount of their efforts were spent on the labourers' administrative affairs.

20. Reclamatory cultivation : Poor adjustment of the agricultural machinery due to the lack of experience of (9) skilled workers caused serious damage in the field already levelled. This made application of water for irrigation of the green manure crops very difficult. Also during reclamatory cultivation seeds were sometimes placed too deep in the soil (see p.219) due to carelessness of (9) skilled workers on the part of the tractor drivers. The fact that machinery, seeds, fertilizers etc. had to be imported from abroad and very often were not obtained at the right time was a further problem and in part negated the positive factor of availability of capital. Due to (7) bad management, ill-timed execution of the project and poor performance of (9) skilled workers in the preparation of fields the project was unable to make full use of the potential soil fertility and to build up a favourable soil structure which a basic requirement for the production stage.

22. Maintenance of irrigation and drainage system : Maintenance of the project components is essential in order to keep the project functioning, but this was not so in this project. The (10) number of maintenance labourers was not enough to keep the irrigation canals and drainage ditches in good conditions and

FIG. NO. 7.3.5

Reality Interdependence of Phase Two - Stage 2

Dominant	Secondary	1 Capital application and investment	2 Climate	3 Soil levelling	4 Soil salinity	5 Water - quantity	6 - quality	7 Management	8 Know-how	9 Skilled workers	10 Maintenance labourers - Number	11 - Education	12 - Training	13 Future settlers - Number	14 - Education	15 - Training	16 Leaching processes	17 Irrigation processes	18 Workshop	19 Agro-technicians	20 Reclamatory cultivation	21 Inner wind-breaks	22 Maint. of irrig. drainage system
Capital application and investment	1		o	+	+	o	o	o	+	+	+	+	+	o	+	+	+	+	+	+	+	+	+
Climate	2	o		o	-	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	+	+	?
Soil levelling	3	-	o		-	-	o	o	o	o	o	o	o	o	o	o	-	-	o	o	-	o	o
Soil salinity	4	-	o	o		+	+	o	o	o	o	o	o	o	o	o	o	o	o	o	-	o	o
Water quantity	5	o	o	o	-		o	o	o	o	o	o	o	o	o	o	-	-	o	o	-	-	o
quality	6	o	o	o	+	o		o	o	o	o	o	o	o	o	o	o	o	o	o	+	+	o
Management	7	o	o	-	-	o	o		o	+	-	-	-	o	-	-	-	-	-	+	-	+	-
Know-how	8	o	o	+	+	o	o	+		+	o	o	o	o	o	o	+	+	+	+	+	+	+
Skilled workers	9	o	o	-	-	o	o	o	o		o	o	o	o	o	-	-	-	-	o	-	o	-
Maintenance labourers No.	10	o	o	o	o	o	o	o	o	o		o	o	o	o	o	-	-	o	o	-	o	-
- Education	11	o	o	o	o	o	o	o	o	o	o			o	o	o			o	o	o	o	
- Training	12	o	o	o	o	o	o	o	o	o	o			o	o	o			o	o	o	o	
Future settlers No.	13	o	o	o	o	o	o	o	o	o	o	o	o		o	o	-	-	o	o	-	+	o
- Education	14	o	o	o		o	o	o	o	o	o	o	o	o					o	o			o
- Training	15	o	o	o		o	o	o	o	o	o	o	o	o					o	o			o
Leaching processes	16	-	o	-	-	-	o	o	o	o	o	o	o	o	o	o		-	o	o	-	o	o
Irrigation processes	17	-	o	-	-	-	o	o	o	o	o	o	o	o	o	o	o		o	o	-	+	o
Workshop	18	?	o	o	o	o	o	o	o	o	o	o	o	o	o	o	-	-		o	-	o	-
Agro-Technicians	19	o	o	-	-	o	o	o	o	-	o	o	o	o	o	-	-	-	o		-	+	o
Reclamatory cultivation	20	+	o	o	+	+	o	o	o	o	o	o	o	o	o	o	o	o	+	o		o	o
Inner wind-breaks	21	o	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o
Maint. of irrig, drainage system	22	?	o	o	-	+	o	o	o	o	o	o	o	o	o	o	-	-	o	o	-	?	

they were not able to execute major maintenance jobs, but an external contractor has to be hired, as when the main irrigation canal is broken.

Due to (7) poor management supervision and carelessness of the labourers (2) an apparently minor element of climate, the dusty wind, blows dry bushes, empty fertilizer bags and sand into the ditches blocking culverts and pipes which caused serious problems when rain fell(see pp.216&242). The irrigation canals were treated just as carelessly as the ditches. (9) skilled workers were not able to clean the drains of weeds and sand and their application of the wrong machinery led to destruction of the side-slopes and gradient. (18) Workshop has a hand in this bad maintenance as sometimes the right machinery is not ready when it is wanted: Fig. No. 7.3.5 shows these consequences.

Third Phase

As the production phase has not been implemented so far and thus there are no settlers, no farms allocated, no agriculture cooperative introduced etc. an interdependence analysis of the development factors in the Third Phase cannot be carried out here.

Summary and Conclusion

1) It has to be born in mind, not only in this project, but in any project that -

a. Flexibility must be maintained to facilitate adaptation to changing technical, political and socio-economic conditions

b. However, options of changing design cannot be kept open for an indefinite time period i.e. the decision of building a project, which is taken today according to the engineering aspects, socio-economic aspects, capital and market etc. has to be taken on the basis of the best forecast for a specific future period and will rapidly lose validity after this.

2) In any project there will be critical convergence and divergence points; there will necessarily be a sequential flow of inputs and specific technical operations limited to real time periods. Every operation is essential to the progression of the project to the next operation, next stage and next phase - any extension of the time taken reduces the validity of the forecasts on which the design was based.

3) There are several kinds of problems and difficulties which have hindered the project's progress :

a. Some delayed individual input factors caused delay in the next step of performance.
b. Other input factors, improperly handled, led to a temporary reduction in the project's progression and production level.
c. Other input factors were adversely affected by technical mistakes, leading to permanent reduction in the project's production.

Lastly, therefore, the question arises of whether the project has either partly or wholly failed. Thus, since it could be maintained that the project's primary objective was to create 300 families of farmer-settlers, by November 1975, and this was not achieved, the project may be seemed to have failed. However, various subordinate objectives, e.g. the reclamation of new farmland, or, the establishment of new agricultural potential, may be said to have been partially achieved, although the improper handling of the essential input factors has reduced the level of performance to a point significantly lower than projected in the plan.

Here it would be useful once more to apply the concept of the Law of the Minimum. First, at the small scale we could state: "By the deficiency or the absence of one necessary constituent such as the main irrigation canal, all the other factors present such as technicians, labourers, heavy machinery, management etc., the irrigation system is rendered ineffective for all processes of leaching and irrigation, to the life of those crops to which that one constituent is indispensable".

Secondly, on a larger scale "By the deficiency or the absence of one necessary constituent such as the management, all the others present such as climate, labourers, capital and know-how etc. the project is rendered ineffective for all processes of development to the life of which that one constituent is indispensable".

The continuing problem of inadequate leaching and reclamatory cultivation, even if the small number of ill-trained settlers had been allocated land, would have resulted in even that land which was reclaimed and is in production being subject to deterioration.

By the end of 1977 there were no true settlers but only wage-earning farmer-labourers producing a low volume of a small range of crops, partly on a production basis, partly on a land preparation base on a smaller area than planned, with an irrigation system working well below theoretical capacity. These 100 workers were living in the partially completed central village and the operation was still under the control of the General Company. All the information which it has been possible to obtain since, suggests that the project area is still on a "care and maintenance" basis with some small production.

4) It is obvious that the suitability of the individual developing factors can either be conducive to success, or can be inhibiting or possibly inhibiting for development. However, these are not the only elements which determine the final state of the project development.

The suitability of some factors can be changed because their influence can be affected by other interdependent factors. The result of this interdependence is the vital and the conclusive factor in determining the state of development.

It is obvious also that if the suitability of an individual factor is positive it will not necessarily always mitigate the negativity of another individual factor. The obtaining of a positive linkage between dominant and subordinate factors requires a successful inter-relationship of two/or more individual factors: An example of that is afforded by capital whose positive suitability is demonstrated by the supply of machines could be afforded to construct the required irrigation and drainage systems in order to mitigate the negativity of the saline soil by leaching; thus hypothetically it was presumed that the interdependence was as the following equation:-

Interdependence of

$$\left.\begin{array}{ll} \text{Capital} & (+) \\ \text{Technicians} & (+) \\ \text{Management} & (?) \\ \text{Labourers} & (+) \\ \text{Know-how} & (+) \end{array}\right\} \longrightarrow (+) \begin{array}{l}\text{dominant} \\ \text{linkage}\end{array} \longrightarrow \begin{array}{l}\text{Construction of irr.} \\ \text{and Drainage systems}\end{array} \longrightarrow$$

→ Access to good leaching → soil free of salts.

But in reality this process required five individual factors interdependent with every other in a relatively complex manner. Since no true preparation, monitoring of balance, or checking for that interdependence took place, together with misuse of heavy machinery by the technicians and the inexperience of management, and the powerless role of know-how contributed by foreign specialists led to bad earthworks and consequently bad construction of the irrigation and drainage systems -

So, the real equation is as follows:-

Interdependence of

$$\left.\begin{array}{ll}\text{Capital} & (+)\\ \text{Technicians} & (-)\\ \text{Management} & (-)\\ \text{Labourers} & (+)\\ \text{Know-how} & (+)\end{array}\right\} \longrightarrow (-)\ \begin{array}{l}\text{dominant}\\ \text{Linkage}\end{array} \longrightarrow \begin{array}{l}\text{inadequate const. of}\\ \text{Irr. and Drainage systems}\end{array} \longrightarrow$$

→ Access to leaching with difficulties and problems —

→ Soil, not free of salts.

However, because of the adverse effect, through the interdependence of the five elements, of inadequate management and technicians an adequate construction of irrigation and drainage systems was not carried out.

Both the irrigation and the drainage systems are essential for the project success even if the rest of the project's components had been satisfactory.

We have therefore tried to establish an analytical scheme, involving three main conceptual approaches, critical path analysis, the law of the minimum and factoral suitability and interdependence, to help clarify not only what has gone wrong with the Tauorga project, but could perhaps be used to assist the formulation of project plans in a way which might increase the probability of success. Before we examine this further we shall apply, in a summary form this method of evaluation analysis to some other projects to see whether it has a more general validity.

CHAPTER EIGHT

In chapter 7 an attempt was made to review, fundamentally and typologically, what has happened in the Tauorga project by applying various analytical methods. This may also enable us to devise approaches to the integrated evaluation not only of the Tauorga project but also to analogous projects in general. In order to test the more general validity and relevance of the analytical methods used in Chapter 7, we shall apply them, in a shortened form, to three other analogous agricultural projects located in -

A. United Arab Emirates

B. Oman

C. Saudi Arabia

A. The United Arab Emirates/Trucial States

Summary Introduction

The project analysed below was commissioned by the Trucial States Development Office in the 1960's, before the formation of the UAE, and was confined to the six northern states (excluding Abu Dhabi). In 1963 Sir William Halcrow and Partners were asked to carry out a Hydrological and Groundwater Survey in the area, in order to establish a basis for an economic development programme including agriculture. Following the publication of the Halcrow Report (1) in 1965, Professor H. Bowen-Jones of the University of Durham was asked to carry out a Survey of Soils and Agricultural Potential and to make development recommendations. The consequent reports produced in 1967, the Reconnaissance Survey Report 1966-67 (2), and the Mileiha Development Project and Hamraniya Development Area Report 1967 (3), formed the basis for the Mileiha Development Project which started in 1967. Thus, in the terms we used for the Tauorga operational sequence, Phase I, the Study and Survey Phase extended from 1963 to June 1967; the decision to implement a development project was taken in January 1967; and Phase II, construction, started at the end of 1967.

The data used in the following analysis are mainly taken from the reports mentioned above, together with other contextual information and what material has subsequently become available.

The seven Trucial states covered an area of nearly 128,000km^2, the total population in 1968 being 180,000. (4) Total population employed in agriculture was estimated to be 7,208. (5) Although project development was strictly only carried out in terms of the production resources of the six northern states, Abu Dhabi, following the rapid rise in oil revenue was becoming the main source of finance for the Development Council and also a rapidly growing market for agricultural products.

It was estimated that there were about 2,000 cultivation units in the northern Trucial states (excluding Abu-Dhabi), (6) broadly classified according to their economic function as follows: (7)

a. Subsistence units with only accidental exchange on a very irregular basis if at all.

b. Subsistence units with incidental exchange on an irregular basis.

c. Market oriented units usually fulfilling subsistence function as well.

About 2,500 ha. were estimated to be cropped with fruit trees of which about 90% are dates and the rest mainly lime and a few other citrus fruits, together with mangoes, bananas, guavas, pomegranates, figs etc. [8] There was some cultivation of alfalfa and occasionally other crops under trees. About 300 ha. are planted each year with winter vegetables of which tomatoes occupy some 70%.

Labourers' inputs vary considerably; on some units a working day of up to 6 hours per man would seem to be normal, whereas on others it would be as low as 3 to 4 hours. [9]

The forms of land tenure in the Trucial States are [10] - ruler's gardens, private gardens - owned freehold, private gardens - owned without freehold, private gardens - occupied without payment on a usufruct basis.

Standards of husbandry vary considerably. The most relatively sophisticated methods within what is in general a very unsophisticated environment technologically were found on those gardens producing regularly for the market, the great majority of which were in the recently colonised area of southern Ras al Khaimah. Other gardens showed a low level of technical efficiency and the standards of cultivation and irrigation were generally poor.

The biggest market for all the agricultural produce of the Trucial States was Dubai, which was both a centre of final consumption and the most important centre of distribution to the rest of the area. [11] A small proportion was marketed collectively through the agency of the agricultural station at Digdaga. There was no governmental control on price and supply of agricultural commodities, no standardization of grading, packing or weighing. Few storage facilities existed and produce handled by small merchants or taken to market by producers had to be transported over a rough track, although plans for a hard-top road network were being considered.

The agricultural situation in the Trucial States could be summarized as follows - Agricultural potential was limited through the physical environment; complete dependence on irrigation of the small areas of soil suitable for cultivation; high water requirements and the relatively small available water supply because of the tendency of soils and ground water to deteriorate under the conditions that prevailed. The surveys, however, showed there were limited unused resources of soil and water still available and that there was scope for more economical use of water.

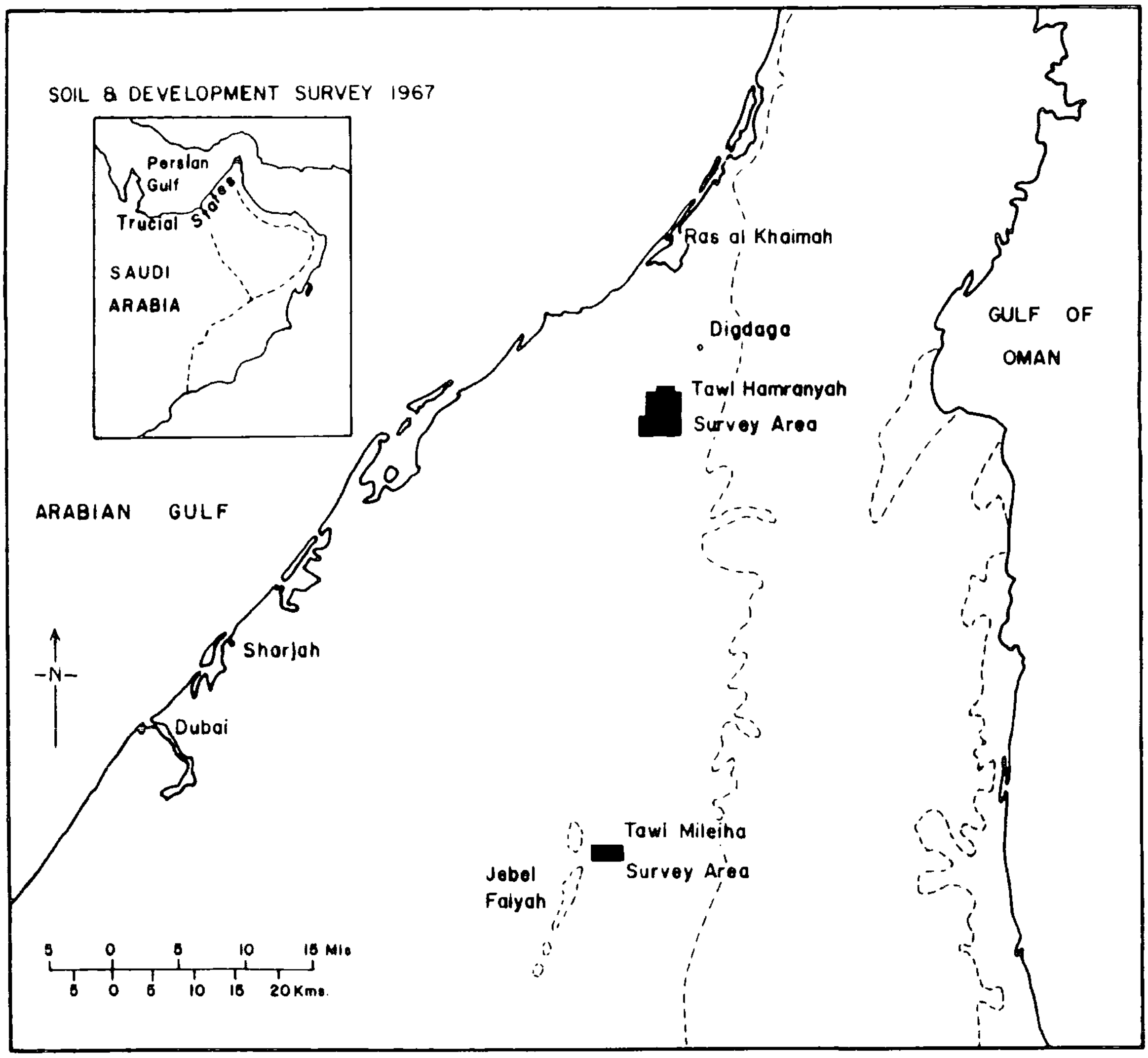
8-1 Mileiha Pilot Irrigation Project

In January 1967 the Trucial States Development Office asked Sir W. Halcrow and Professor H.Bowen-Jones in consultation to submit outline proposals and estimates for the possible development for a Mileiha pilot irrigation project.

These proposals included an estimation for the necessary lay-out and supply of water to irrigate an area of approximately 120 ha. in the vicinity of Tawi Mileiha east of Jebel Faiya[12] (see Fig. No. 8-1.1). This would be divided into plots of approximately 4 ha. in tenant or other farm holdings or alternatively, in larger plots which would be regarded as production units. Each 4 ha. plot was recommended to be cultivated as follows:-[13]

Treecrop 1 ha.	
Winter vegetables 1.5 ha. following by	0.75 ha. leguminous fodder
	0.75 ha. summer fallow
Winter leguminous 1 ha.	0.5 ha. summer fallow
Fodder	0.5 ha. " vegetables
Winter fallow	0.5 ha. followed by 0.5 ha. spring vegetables

Fig. No. 8-1.1 Survey Areas, Mileiha and Hamraniyah - Location



Source : After H. Bowen-Jones, and J. H. Stevens, Mileiha Development Project-Hamraniyah Development Area, Department of Geography (University of Durham) 1967

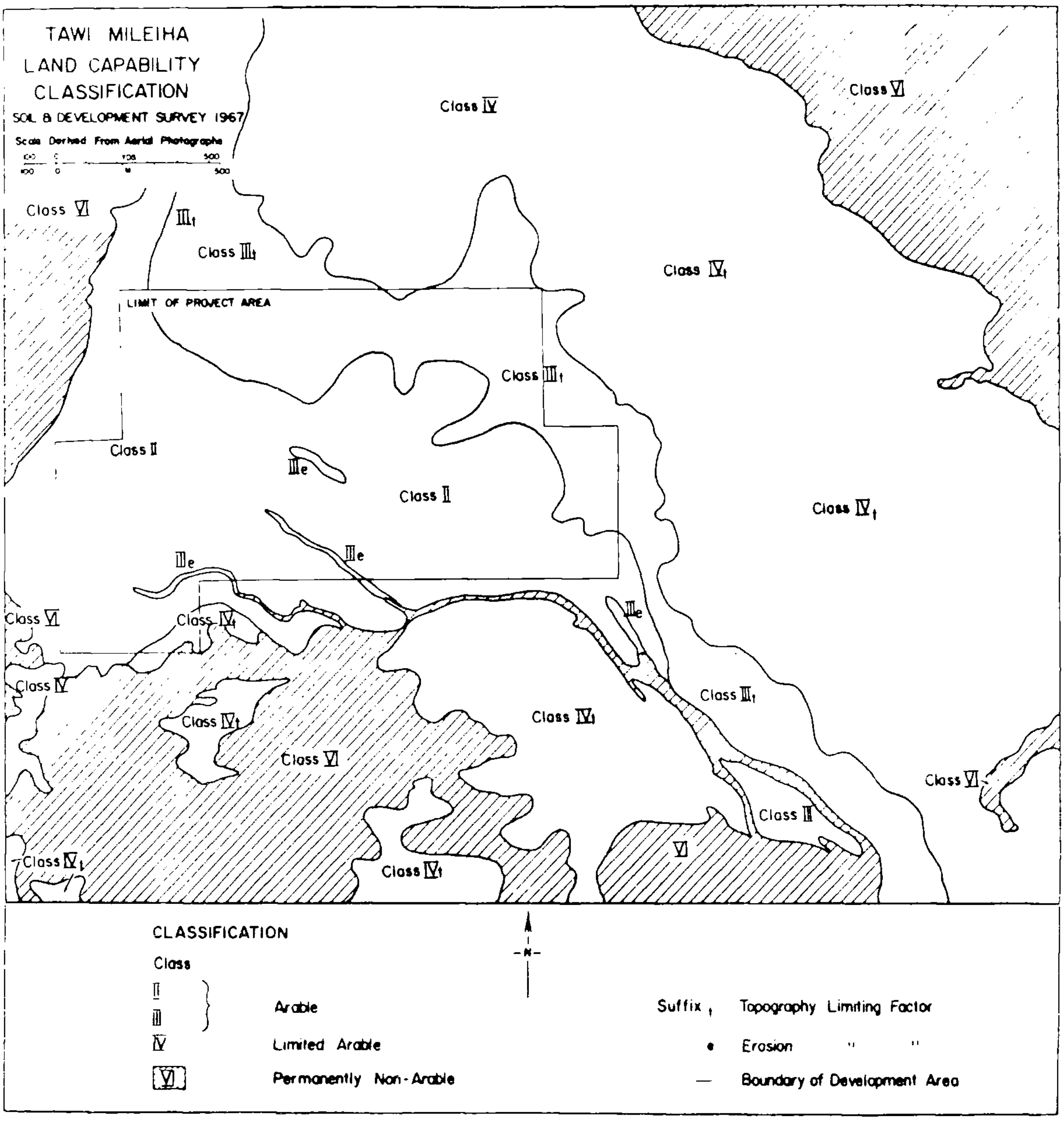
The whole area of 120 ha. represents an approximate proportion of a sixth of the total area which might subsequently be utilized for agricultural development. A summary of the findings of the reconnaissance survey are shown below -

Climate: hot and arid; rainfall is very low and unreliable, ranging during the 30 years for which records are available at Sharjah from practically nil in 1961-62 to over 250 mm. in 1956-57 with an annual mean of 107 mm. (14) Evaporation rates are among the highest recorded anywhere, for example evaporation at Tawi Mileiha is about 4300 mm. (15) Great range of humidity and temperature is experienced daily and seasonally, together with the periodically strong wilting effects of wind action. (16)

Soil: The area of land suited to agricultural development at Mileiha is shown in Fig. No. 8-1.2. The land suitable for commercial development is of Class II and III capability, Class IV land is suitable for specialized arable use and Class VI land has no arable value. (17) Soils are derived from the sands and silts deposited in gravel plains and washed from the Hajar mountains to the east. The predominant soils in the area are of coarse texture, generally sandy loam. (18) A caliche horizon certainly underlies soils in the east and south of the survey area and it is likely that this caliche horizon underlies the whole of the survey area and could impede drainage. (19) Fig. No. 8-1.3 indicates the detailed soils map.

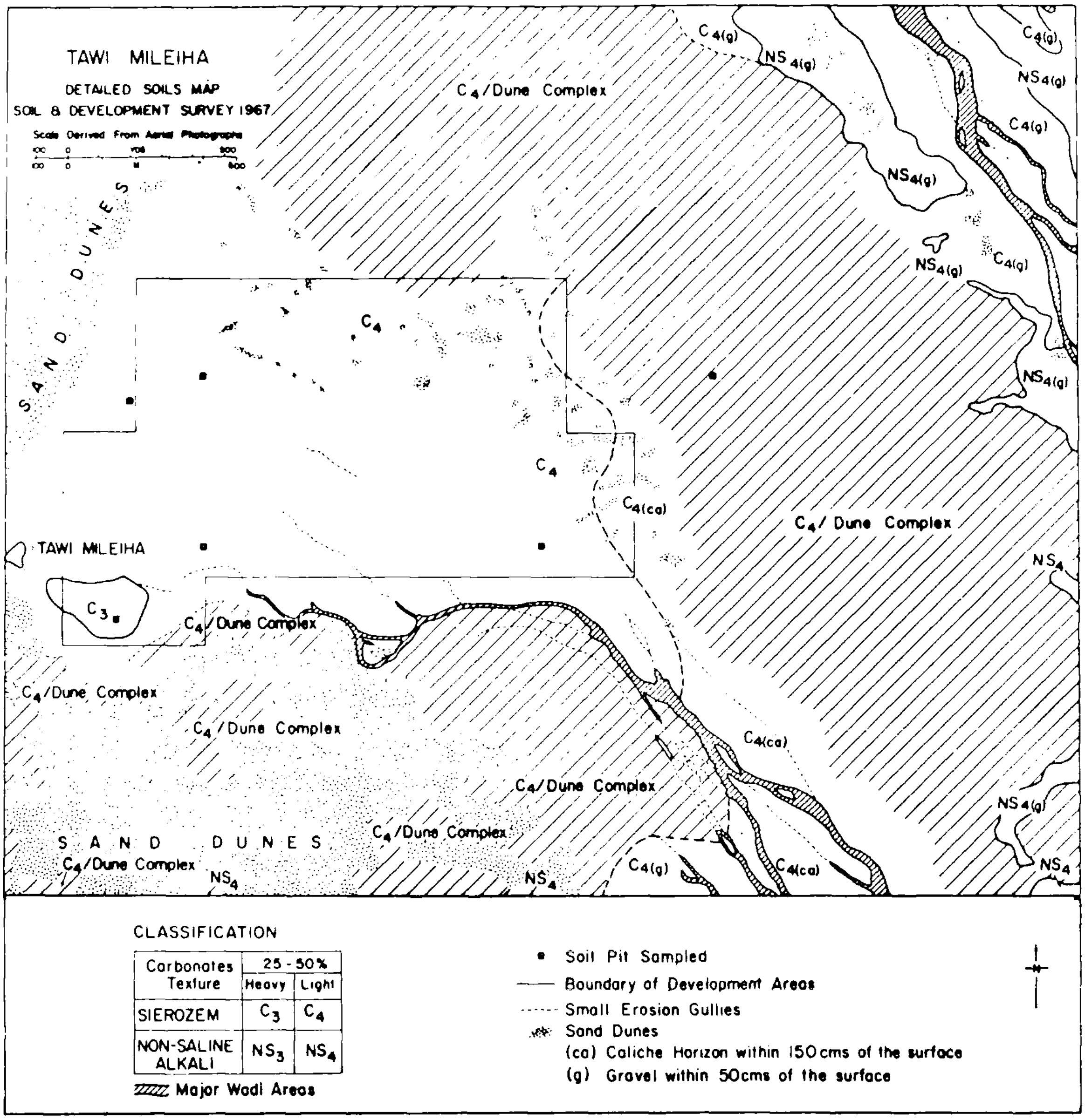
One point needs emphasising, i.e. the high free calcium carbonate content in the soils, reflecting the nature of parent material. (20) Beside having an inherent low fertility, the soils in this project area also have a low water holding capacity, whilst the funnelling of westerly winds between the Jebel Faiyah and the Jebel Mileiha may also significantly affect evapotranspiration.(21)

Fig. No. 8-1.2



Source : After H. Bowen-Jones and J. H. Stevens, Mileiha Development Project - Hamraniyah Development Area, Department of Geography (University of Durham) 1967

Fig. No. 8-1.3



Source : After H. Bowen-Jones and J. H. Stevens, Mileiha Development Project - Hamraniyah Development Area, Department of Geography (University of Durham) 1967

In the east of the area, the silt and clay percentage (U.S.D.A. size limits) drops below 20 and the net result of these factors is that a high level of application of irrigation water will be necessary to avoid drought. [22] Both saline and non-saline alkali soils are found in which plant growth is restricted because of excess of exchangeable sodium or because of high total salt content.

Water: The water resources have been described in the Report by Sir W. Halcrow, 1969.[23] There is no surface water other than from the wadi spates which flow when there is rain in the hills. There is groundwater in most of the plains area occurring within 50 m. of the surface generally in permeable formations. [24] Observations suggest that the total groundwater flow across the gravel plains was of the order of 85 million cu. m. a year of which about 56 million might be available for further extraction [25] in the plains east of the Hajar mountains in the northern Trucial States to supply present and potential areas of cultivation in those regions. [26] Its quality near the hills is generally good but it deteriorates as it passes towards the sea because of the salts it picks up on its passage across the plain. Additionally, due to over-application of water on some of now cultivated land excess water seeps back into the water table, taking up salts as it passes down and thereby increasing the salinity of the ground water. However, the quality of water at present being extracted from the Mileiha water field is sufficiently good. [27]

8.1.1 Examination of the planned design and implementation and the actual design by critical path analysis, first requires a statement of the project objectives and processes of development.

Project objectives

The first Tawi Mileiha proposals were for a 120 ha.

agricultural project; should this project succeed then an additional 720 ha. will be introduced for agriculture development as family plots or as a commercial production enterprise employing labour. The implication of family plot development is a change from traditional subsistence farming found in the region but not in this locality into modern farming, from which reasonable incomes would be obtainable. An efficient production unit, even more than with efficient small farm units would contribute to the general economy of Sharjah State in particular and the Trucial States in general. At this point in time no clear picture could be obtained of the future political or economic status of these non-Federated States. The only general policy-making body was the Trucial States Council which was a voluntary association of the Rulers and/or their representatives encouraged to cooperate by the British. The only implementation agency was the Council's Development Office whose work was financed partly by the British Government and increasingly by the Ruler of Abu Dhabi.

Planned development processes of the project (28)

1. The segregation from common pastoral use of the project area by the construction of a perimeter face and flood protection by earth barriers.

2. Clearing the project area of natural vegetation and dividing it into 30 holdings of 4 ha. each.

3. Drilling of twelve wells in a waterfield some 2 km distant and constructing a pipeline to the water storage tanks on the project perimeter.

4. Construction of a flood irrigation system.

5. Establishment of a village close to the agricultural area complete with electric, water and sanitation services, service roads, central maintenance workshop for agricultural machinery,

irrigation, equipment, etc.

6. Windbreak planting around the perimeter and around each holding block.

7. Green manuring in order to improve the soil structure.

8. Production stage.

Actual performance of the project until 1970

1. The perimeter fence was established but the flood prevention barriers were not built. [29]

2. The project area had been cleared and divided into 30 holding blocks.

3. Out of the 120 ha. only 2 blocks each of 4 ha. were under cultivation by 1970.

4. Twelve bore holes and two large storage tanks were located on the large sand dunes just outside the development area. [30]

5. Wind breaks were planted along part of the perimeter and partly around the two cultivated blocks. [31]

6. Of the proposed village only a workshop was constructed. [32]

7. In March 1971 two 4 hectare blocks were being used to produce decorative plants for sale by the project's skeleton staff on the outskirts of Dubai. No other crop production was practised and the project area was essentially on a care and maintenance basis - without farmers. After displaying the project's objectives and the planned and the actual design and implementation it becomes possible to identify the problems and difficulties already existing or predicted:-

1) This type of project is first constrained by critical physical factors i.e. climate, soil, water and which needed

specific technical management. In fact management was extended from Digdaga station and an adequate staff was not installed.

2) In spite of the detailed recommendations for project establishment,[33] these were not satisfactorily applied. For example flood prevention barriers, strongly recommended were not completed. Thus during March 1969 heavy rainfall occurred in the mountains and resulting flash floods area causing serious erosion on all blocks but two, each of four ha., lost their soil completely.

3) The irrigation system of this project is designed for gravity distribution to channel and basin plots. While the surface channels were under construction it was suggested that a sprinkler irrigation system could be used instead. This required a budgetary review and produced the loss of a whole season. It also required a new and experimental approach rather than the use of a locally known system and introduced also a new element of risk -

a. Different technicians or experts would be required to operate and maintain this sprinkler system.

b. Quantity and quality of water also had to be reconsidered and consequently, as well, the area to be cultivated and the cropping pattern.

4) Although the climatic conditions at Mileiha are sufficiently different from those of the main Ras Al Khaimah vegetable growing area so that some differences in cropping and husbandry practices would be necessary to gain the recommended field trials, work was not put on a proper basis.

5) This project was ultimately made into a pioneer settlement and the full implications of this should have been realized.

For example, it was necessary to select the settlers and get them onto their holdings so that they can, through experience, learn how to operate them as commercial units. This was essential because the proposed hypothetical settlers had either never worked in agriculture or at most they had only practised traditional farming. But the major deficit was not merely the ignoring of training farmers but that no pool of potential national settlers was in fact identified. This deficit case is similar to the one we had seen at the Tauorga project. Thus problems and difficulties of carrying out the agricultural processes such as irrigation, which appeared at the Tauorga project, were repeated in this project. Experience at Hail and Faiya Pass, where concentrations of sodic salts, naturally high, have been built up yet further by irrigation, [34] point to the consequences of absence of control of land use.

6) A tendency towards private and independent agricultural development in areas neighbouring to this project was forecast in 1966 and 1967, thus there might have appeared two risks:-[35]

a. Uncontrolled water exploitation even by shallow wells extraction could produce difficulties of water supply and competition like the problems we have seen in the Tauorga project.

b. Since it is likely that private development would tend to use water of relatively high conductivity and to use soils relatively susceptible to deterioration the contamination of soils and ground water in the development area could take place. No measures were taken by the authorities to prevent such future deterioration.

7) It was known that the soil contains a very small, but critical, quantity of fine silts needing good soil-water management

but the planned design did not include drain construction[36] on the assumption that such management would be forthcoming. This assumption was not valid.

Critical Convergence and divergence points

(i) Hypothetical Convergence and Divergence Points

First phase - After the soil and agricultural potential, water, climate, socio-economic survey etc. had been investigated; the decision was taken to construct the project.

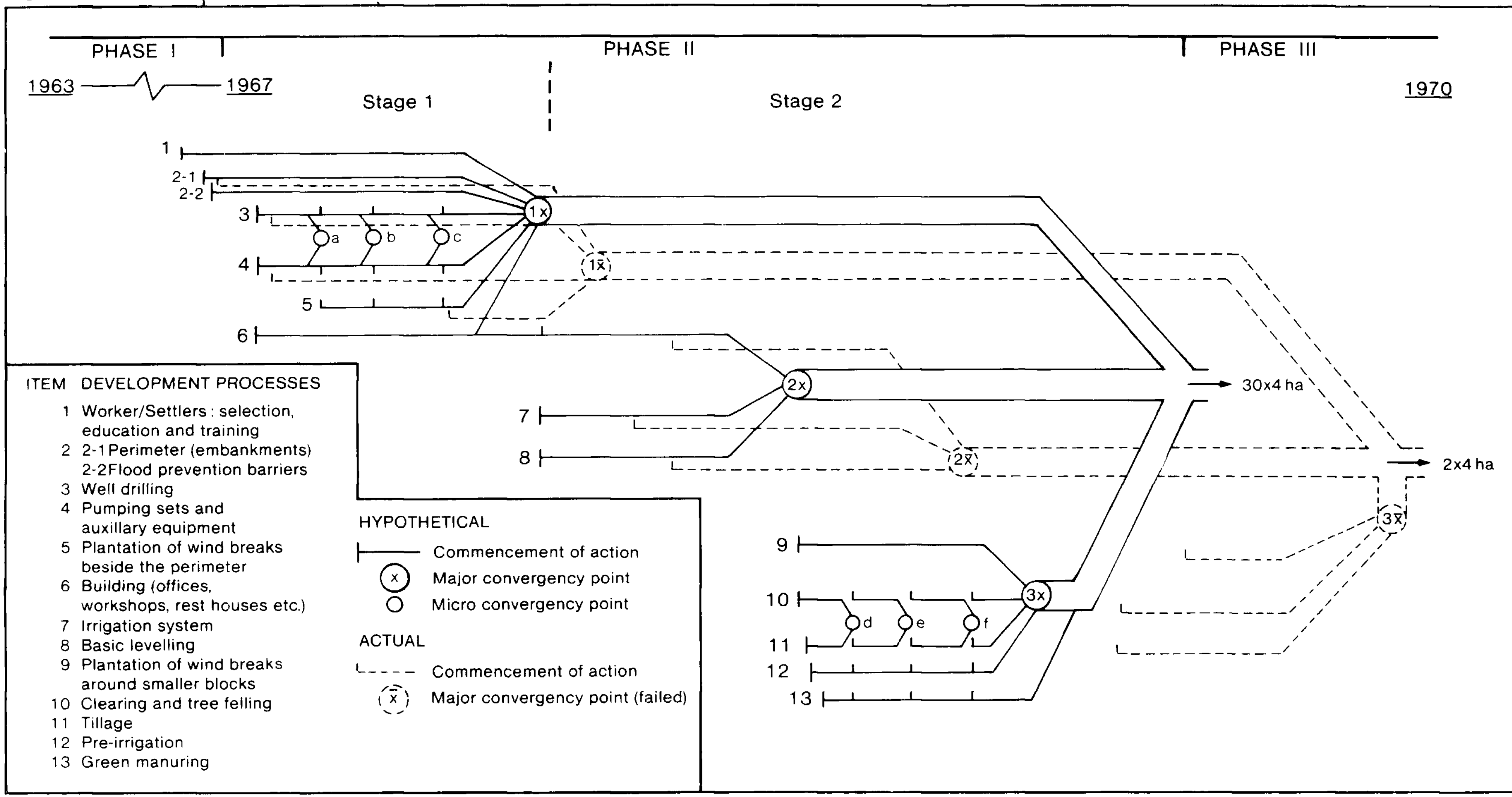
Second phase, stage 1 - During the construction there appeared necessary convergence and divergence points and interfaces in the development process. Their mechanics will not be explained in detail here because they are referred to in Fig.8-1.1.1 and also they are very similar to those covered in Chapter No.7. There are some exceptions and different emphases, and these will be explained below.

First of all the selection of workers/settlers; the programme of education and training for them must be planned before any construction begins.

It is of utmost importance to give priority of construction to the development process No. 2-1 and 2-2 in order to avoid the danger of flash flooding.

Second phase, Stage 2: Item Nos. 7 and 8 should start only after convergency point No.1 indicated as 1X, was reached in order to avoid the danger of flash flooding. But in other projects (such as the one in Kamil Al Wafi in Oman) those items could be started earlier.

Fig No 8-1.1.1 Critical Path Analysis, Planned and Actual Performance, Mileiha Project



Item Nos. 10, 11 and 12 are of particular importance and must be performed in an accurate balance after convergency point No.2, indicated as 2X was reached. Thus in order to avoid wind erosion, Haloxylon salicornicum, should only be removed immediately prior to item No. 11, tillage operation, micro convergency points No. d, e and f. Immediately after tillage, on at least part of the area, item No.12, pre-irrigation and item No. 13, green manuring, must be commenced. The pre-irrigation will aid the settling of the soil, could assist leaching and will encourage the wild grass seeds to emerge for subsequent eradication. However, under no circumstances should item No. 10 be carried out over the whole area unless item No. 11 can be performed immediately and completely.

It is similarly important that item No.13 must start immediately (if sowing time is suitable) otherwise fields must be watered at least to supply leaching requirement and in order to avoid salinity build up in the upper horizons through capillary tube movement of soil moisture.

Phase III: Because of the different classes of the project's soil and variation in structure and texture it is expected that they will require different periods of green manuring. Consequently this production phase will not be started in the whole project area at once but will be introduced in stages.

(ii) Actual Convergence and Divergence Points

It is obvious that the first phase had been started without any plan for the selection, education and training of the settlers.

It was essential and compulsory to start construction with the development process Nos. 2-1 and 2-2 in order to avoid the danger of flash flooding. But unfortunately the development process No. 2-2 was completely ignored.

Development process Nos. 3 and 4 started without observing necessary interface between these two development processes and the development process Nos. 2-1 and 2-2

Development process No. 5 was never completed, just a few rows of trees were introduced along part of the perimeter.

Of development process No. 6, only a workshop was constructed.

However, the first phase was under construction without any priority or order and without any co-ordination between planners, management, supervisors and executors. The result was that the hypothetical convergency point No. 1 could be realized neither in terms of time nor in terms of completion; instead a failed convergency point was obtained, indicated as $1\bar{X}$. This was severely reflected in the second phase as the starting time was missed. The starting conditions and preparation for development process Nos. 7 and 8 were very weak and consequently convergency point No.2, indicated as $2\bar{X}$, never emerged and the project became out of control. The same thing happened with the developing processes Nos. 9, 10, 11 and 12 and consequently convergency point No.3, indicated as $3\bar{X}$ never emerged.

Because of these failed convergency points, it was impossible to reach the production phase. The final situation of the project is shown in (p.318).

8-1.2 The Concept of Liebig's "The Law of The Minimum"

Identification of critical levels of individual inputs and factors which if not reached will either damage or invalidate the project.

Example ; ~~First~~ Second phase (Construction)

Various inputs have to interact in real time in order to form a development process; this follows from our critical path analysis.

However, applying the concept of the law of the minimum : "By the deficiency or absence of one necessary constituent (such as development process No. 2.2 - flood prevention barriers) all the rest of the development process being present, this project is rendered completely ineffective for all processes of cultivation to the life of which that one constituent is indispensable".

Because the absence of the flood prevention barriers led to the serious erosion, the result was that sufficient of the project land was severely damaged as to render part of the area completely ineffective for cultivation.

Example : ~~Second~~ First Phase

Since no efforts were made to establish the existence of potential worker/settlers, the project was rendered completely ineffective. It may be noted that during the mid 1970's, as the result of UAE policies of heavy subsidising all agricultural inputs and the possibility of indulging in "hobby-farming" in the main oil-boom period, all the plots are now owned by urban dwellers and worked by hired expatriate labour; commercial or ecological viability are not relevant.

8-1.3 Suitability and Interdependence of the input factors influencing the project development

The suitability and interdependence of only the second phase, construction, will be investigated here while the third phase will be excluded because it was not actually started.

a. Suitability of the input factors

The same symbols e.g. +, - and ? used in Chapter 7 will be applied here as shown in Table 8-1.3.1. Col. No.1 and Col.No.2 of this Table show the planned and real suitability respectively. The planned suitability of the input factors may be assumed to have been conducive to success.

Real suitability:

Project location - is determined by the presence of cultivable soil and adequate water. It is located in Sharjah. Its importance was a consequence, firstly of favourable physical conditions and secondly, of a hypothetically favourable institutional framework, the Development Council. Thus this item could be given (+) (but see below).

Capital 'fixed' - financial problems were not expected to arise during the construction of the project as long as the construction performance is being carried out according to the plan, scheduled time and the unforseeable difficulties are not so great. But even by May 1967 the Development Council Committee was raising questions concerning the level of proposed expenditure and the technically approved programme was cut-back;(37) these financial problems continued and so this item will be given +/-.

Management - the management and organization of this agricultural project had been carried out by the Works department which was not involved in agriculture. Such a project needs qualified management to implement the ideas of geographers, engineers, agronomists etc. but the Works department did not have this ability. Thus this item is given (-)

Supervision - the Director of Digdaga and his assistants aided by Sir W. Halcrow were inadequate as a team, given only partial responsibility for this project to supervise construction. They were not able to offer sufficient full-time attention. Consequently this item is given (-).

Technicians - were insufficiently skilled and too few to operate the machinery and properly perform the tasks required of this project. Thus this item is given (+/-)

Labourers - they did not play a major role as most of the work was done mechanically. This item is given (0).

Topography [38] - slopes vary, ranging from 2^{o} to 5^{o}; this allowed sizes of plots to give lengths of minimum irrigation run from 200 metres to 50 metres. Thus no problem will arise for applying flood irrigation systems. Thus this item is given (+).

Perimeter - was not satisfactorily constructed or completely protected by wind breaks in order to at least lessen the flood which took place. Thus this item is given (-).

Flood prevention barriers - were completely forgotten, and thus given (-).

Irrigation system - was not fully constructed, but the not adequately explored idea of changing to sprinklers from the flood irrigation system (see p.319) is sufficient reason for giving this item (-).

Table 8-1.3.1 Suitability of factors influencing the Project development

Factors of Development	(1) Hypothetical	(2) Actual	Remarks
Second phase, Stage 1			
Project location	+	+	
Capital "fixed"	+	+/-	
Management	+	-	
Supervision	+	-	
Technicians	+	+/-	
Labourers	+	o	
Topography	+	+	
Perimeter	+	-	
Flood prevention barriers	+	-	
Irrigation system	+	-	
Buildings (offices, workshops resthouse, etc.)	+	-	
Wind breaks	+	-	
Second Phase, Stage 2			
Climate	+	+	
Capital "Current"	?	?	
Soil			
- Levelling	+	-	
- quality	+	-?	
- quantity	+	-?	
Water			
- quality	+	+/?	
- quantity	+	+/?	
Management	+	-?	
Agro-technicians	+	-?	
Skilled workers	+	-?	
Settlers/farmers	+	-?	
- selection			Not considered at all in the plan
- education			" "
- training			" "
Wind breaks	+	-	
Irrigation process	+	-?	
Green Manuring	+	?	
Third Phase			
Cropping pattern	+		
Transport	+		Not carried out
Market and marketing	+		
Farm size	+		
Family size	+		
Family income	+		
Land Tenure	+		
Project maintenance	+		

Village - apart from the workshop nothing was constructed. The lack of any construction priority e.g. resthouse, offices, workshop etc. means this item must be given (-).

Windbreak - inspite of its necessity to stop the soil creeping and for the creation of more equable micro-climate conditions within the plots, wind breaks were only partly planted and the whole layout of blocks of tree crops which would also serve as wind breaks was incorrectly changed. This item must also be classed (-).

b. Interdependence of the input factors

(1) Project Location : The project location has created the necessity of establishing (8) perimeter and (9) floor prevention barriers, which consequently mean additional costs. This fact has to be accepted because the need was predicted in the pre-feasibility study and there was no alternative location.

(2) Capital "fixed" : The capital allocation had to be reconsidered because of the idea of altering the irrigation system as well as changes of attitude in the controlling committee for political reasons.

Originally, it could be presumed that no financial problems would arise, but due to the improper construction of (8) perimeter and the complete absence of (9) flood prevention barriers a lot of money was wasted.

(3) Management : The management was not able to manage and organise the work performed by (5) technicians and (6) labourers such as (8) perimeter. Even the balance of priority of construction was lost, thus (9) flood prevention barriers were neglected which negatively affected on (7) topography, 10 (irrigation system) and (11) village and led to the situation in (P.318).

(4) Supervision : Was not available to advise (3) management or to supervise the construction performed by (5) technicians and (6) labourers, thus the part-time supervisors shared the mistakes of the management.

(5) Technicians : They were not able to operate the required machinery and to construct (8) the perimeter properly. Thus the poor (3) management and (4) supervision reflected on the rest of the project components (see p.318). (7) topography and (10) the irrigation system and (11) village were not completely constructed and thus can not be technically assessed.

(6) Labourers : Except for machinery, they are the same as for (5) technicians.

(7) Topography : The gentle slope of the topography will facilitate the construction of (10) irrigation system. Unfortunately, this had not been obtained due to (3) management, (4) supervision and (5) technicians etc.

(8) Perimeter : Was constructed incompletely and improperly by (5) technicians, (3) bad management and poor experience and part time engagement of (4) supervision. The result was waste of (2) capital fixed; yet the erosion was caused (see p.324).

(9) Flood prevention barriers : The complete absence of this item due to (3) bad management and (4) supervision very severely influenced (8) perimeter and it contributed to the bad situation described in (p.318).

(10) Irrigation system and (11) village : Both of them were not completely constructed and thus cannot be assessed.

Figure No. 8.1.3.1 Interdependence of input factors, First Phase, construction

	Secondary	Project location	Capital "fixed"	Management	Supervision	Technicians	Labourers	Topography	Perimeter	Flood prevention barriers	Irrigation system	Village	Wind breaks
Dominant	1	1	2	3	4	5	6	7	8	9	10	11	12
Project location	1		o	o	o	o	o	+	+	+ +	o	o	+
Capital "fixed"	2	o		o	o	o	o	+	+	+	+	+	o
Management	3	o	o		o	-	-	-	-	-	-	-	-
Supervision	4	o	o	-		-	-	-	-	-	-	-	o
Technicians	5	o	o	o	o		o	?	-	o	?	?	o
Labourers	6	o	o	o	o	o		o	-	o	?	?	o
Topography	7	o	?	o	o	o	o		o	o	+	o	o
Perimeter	8	o	-	o	o	o	o	o		o	-	-	o
Flood prev.barriers	9	o	?	o	o	o	o	o	-		-	-	o
Irrigation system	10	o	-	o	o	o	o	o	o	o		o	o
Village	11	o	?	o	o	o	o	o	o	o	o		o
Wind break	12	o	o	o	o	o	o	o	o	o	o	o	

Conclusion

By analysing as we have done the Mileiha project we can note that many of the reasons for lack of success in implementing a policy decision are similar to those we found in Tauorga. For example much of the project's land resource was severely damaged due to, firstly, ignoring the order of the convergent and divergent points of the project construction (consequences of which are shown in Fig. No. 8-1.1.1), this further emphasized by applying the concept of the law of the minimum. Secondly, the way in which the interdependence of input factors was not sufficiently recognised complicated the construction development processes instead of "lubricating" them.

If we now compare this project analysis with that of the Tauorga project we find that -

a. This project virtually collapsed.

b. Many if not all of the causes of failure were of the same type as found in the Tauorga project. Therefore, the question arises, could these causes have been foreseen at either or both the decision stage and design stage?

As we shall see our analyses begin to suggest that if we take seriously :

(i) Critical path analyses and the convergent and divergent points

(ii) Law of the minimum.

(iii) Interdependence of the input factors; that certain desiderata could be fed in before not after project implementation.

In the conclusion to this thesis we shall be considering this further, but already some points can be made.

First, we can note that in the Mileiha case the stated objective was not as clear as the specific terms of reference would seem to imply. For example, at no time during Phase I or even at the commissioning stage of Phase II was there a firm commitment to anything more than the establishment of the physical services necessary for the irrigation of 120 hectares of land. Further no investigation of the potential demand for family holdings was carried out. Whilst the layout in 4 hectare units had clear technical as well as socio-economic implications these were not given serious consideration at the decision making stage. In other words the minimal requirement of production labour input was not recognized as critical. Secondly, the technical decision to concentrate water-extraction in a single water-field and then to distribute water to land units through a central system was not integrated with a management or advisory system. In other words, the interdependence between water extraction and distribution on one hand and irrigated land management and the production of specific crops on the other was not sufficiently recognized. Thirdly, the necessity for the implementation processes to be sufficiently integrated to allow each stage to proceed from a sound base was ignored. For example, the requirement that a flood barrier be constructed at the initial stage of phase II was not met and the full implementation of further land reclamation was rendered impossible. Fourthly, as critical path analysis in real time reminds us, a project which is conceived only in terms of the situation then existing, may by the time of its completion have to work in a totally different context, so that here, British economic and political intervention almost disappeared at the end of 1970.

A totally new political and organisational setting was created by the federation of the United Arab Emirates. By 1971 Dubai and Sharjah had become oil producers, in addition to Abu Dhabi, and the population of the UAE states, first enumerated in 1968 expanded enormously during the 1970's. A project valid in 1966 and which could have been valid (if the 5 months construction schedule had been kept to) in 1968, has to be seen very differently in fact even by 1970. These and similar points which appear are very similar to those we identified in the Tauorga project and their fundamental importance to projects of this kind is further tested in the case-studies which follow.

B. Oman

8-2 Establishing Commercial Farming in Interior Oman

Introduction

Here we apply the same methods of analysis to project proposals which were never implemented. In this case, therefore, we are not examining a situation after implementation, but considering in what ways project objectives, design and recommendations can be evaluated. This should also extend the testing of the value of our analytical approaches.

In 1976 Hunting Technical Services Limited undertook a pre-feasibility study to ascertain the practicability of commercial farming in interior Oman, [39] this in support of official Omani development policy of encouragement and support for the rural areas in developing modern agriculture so as to[40] (a) slow down out-migration, (b) create a measure of prosperity in the interior.

The feasibility of commercial farming was interpreted as the development, under profitable agricultural/livestock enterprises, of contiguous areas based on the extraction of ground water, the application of modern management methods, a high degree of mechanisation and the minimum usage of labour and to involve land reclamation and new settlement.

However, the proposal in its original form could not be recommended for several main reasons [41]:-

1. Water esource studies to date gave little indication that ground-water was available in sufficient quantity and at reasonable depth, in any one area to allow large scale contiguous development.

2. Other physical constraints, including aeolian drift, adverse topography, shallow soil depth, stoniness and possible flooding, also militated against the exploitation of contiguous areas.

Instead, the team recommended that[42] :-

1. The most appropriate way of developing water resources and agriculture in the interior is through the establishment of clusters of high production intensive small farms based on groups of shallow wells embracing the advantages of a modern irrigation layout and efficient watering practices supported by extension services.

2. The proposed farms are based on full time family employment.

3. In order to prove that this approach is acceptable and adaptable to local conditions, a pilot project should be established in a selected area as considered favourable from water, soil agricultural, socio-economical and marketing standpoints.

In terms of actual steps to be taken to realise these objectives the project would need to be established in two stages [43] :-

<u>Stage I</u> : The exact location and size of the pilot area would be defined by means of further water studies (including test drilling) and a semi-detailed soil survey together with relevant agricultural, socio-economical and marketing surveys.

<u>Stage II</u> - would involve drilling, construction of the wells and irrigation system land reclamation, farm layout and the siting and erection of the service centre, comprising stores, machinery service area, office and accommodation for experts.

The extension centre would ultimately be expected to serve a much wider area than the pilot project but would confine its activities to the pilot area until this was operating successfully. It is noteworthy that these sequences are closely analogous to those carried out in the Tauorga project.

Pilot project: The pilot project would include a number of individual farms or farm groups, each group irrigated by one or more wells. They would be situated around the services extension centre which would be linked by a rural road to the nearest village.

Two figures were attached to illustrate this concept and are reproduced in figures Nos. 8-2.1 and 8-2.2.

The first of these shows the service extension centre in relation to the surrounding farms or farm group. For purely planning purposes it has been assumed that 11 wells will be drilled within a selected area of 300 hectares identified during stage one of the development.(44) One well will provide for the needs of the service extension centre and the balance for the surrounding farms, the average yield being about 15 litres per second.

The second figure shows 3 farms grouped around one of the larger wells of approximately 20 litres per second yield.(45)

8-2.1 Examination by critical path analysis of the planned design in order to

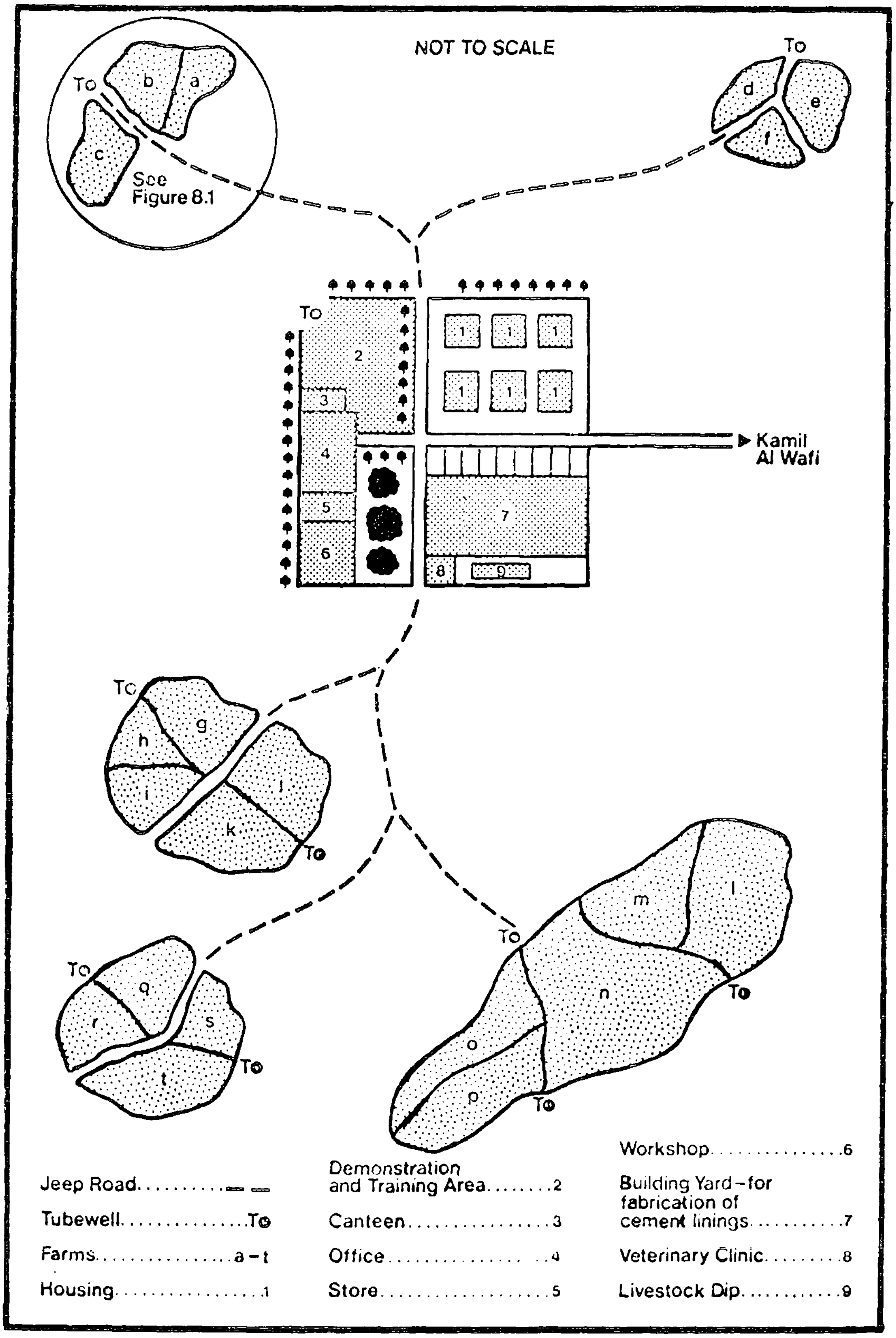
Identify and isolate critical points and stages.

A. Statement of the project objectives :

1. Slowing down out-migration and
2. Creating measures of prosperity in the interior.

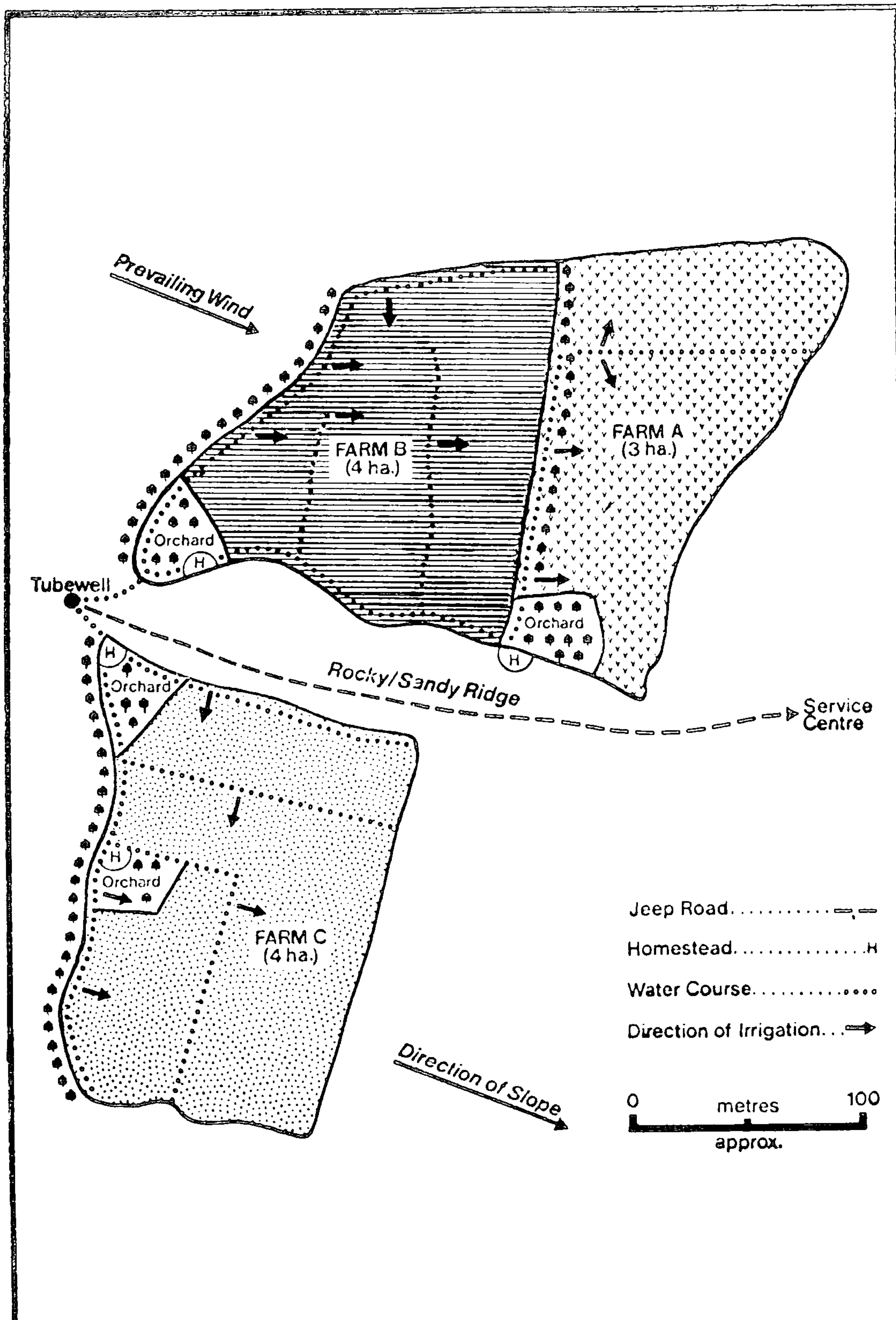
These have to be obtained through developing agriculture in the interior and this by the establishment of high production intensive small farms; the latter will be based on grouped tube well water extraction and distribution, modern irrigation layout,

Fig. No. 8-2.1 Outline concept of a service centre for the pilot project, totalling 20 farms/about 80 ha.



Source : Hunting Technical Services Ltd.

Fig. No. 8-2.2 Outline concept of three farms served by a single tubewell of 20 litres per sec. capacity



Source : Hunting Technical Services Ltd.

efficient watering practices and full extension support.

Statement of the project development processes

There are no real processes of development because there is no decision yet taken to construct the project.

The planned development processes are shown in(pp.334-335) and will be subjected to analysis later in this section.

To obtain specific objectives, for example to diminish rural out-migration, some prerequisites are needed.

1) Income from each farm must be -

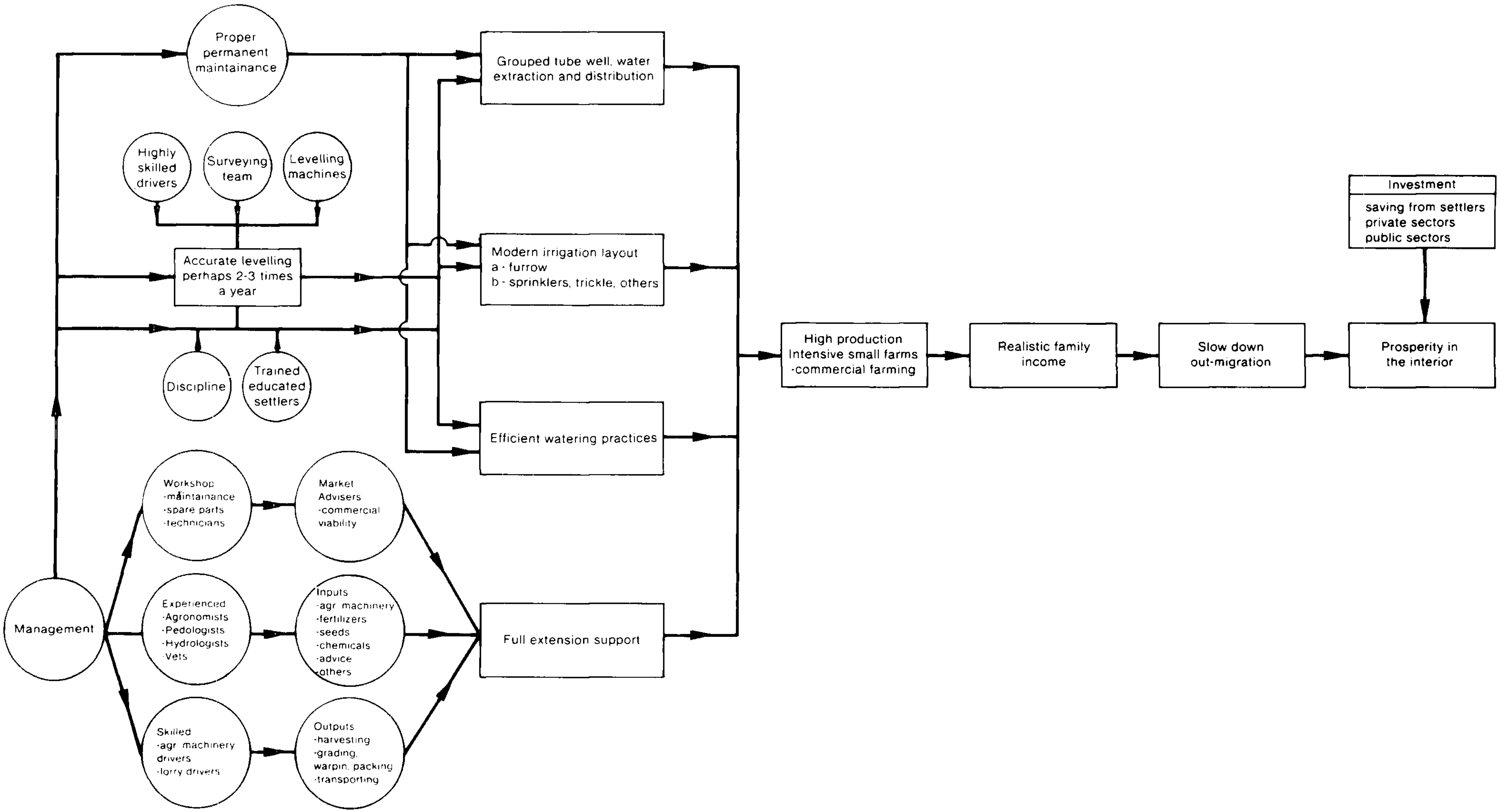
a. Enough to meet the expenses necessary to maintain the family at a better standard than the present standard of living, or at a standard compatible with the socio-economic and political objectives pursued.

b. Sufficient to meet the cost of producing and marketing the products and the payment of taxes and, perhaps, interest on any possible long-term loan obtained for purchasing the land and payment for installation of equipment.

2) Success in creating measures of prosperity in the interior will depend not only, but mainly, on the creation of savings and disposable income over and above that required by the farmers for farm operations and immediate family needs. Such savings and the spread effects of higher demand, together with other non-farming initiative in investing in secondary activities would all be necessary for generating self-sustained growth in the interior as well as government pump-priming.

Large-scale commercial farming could not be recommended because of the reasons mentioned in (pp. 333-334)instead high production intensive small farms were recommended and this recommendation needs to be analysed (see Fig. 8.2.1.1).

Fig No 8-2.1.1 Critical Path Analysis of the Planned Design



1. Grouped tube well water extraction and distribution

This decision is very important and must be treated with reserve as it is the decisive technical resource factor in the agriculture development in the interior. It has to be confirmed that:-

a. the proposed wells will not be competitive with the aflaj, noting that experience proved that wells are superseding the falaj*, (46) otherwise problems will arise as happened in the Tauorga project.

b. a sufficiently detailed study is made of the geological structure and the hydrological situation in the area. But it is clearly mentioned that:(48)

i. No wells have yet penetrated and tested the tertiary limestones, though these may have some potential.

ii. Most of the groundwater of the region is extracted by aflaj.

The assumption that existing wells are insignificant (49) and can be ignored is dangerous given the larger number of hand-dug wells catalogued in the region by Renardet (1975) (50). The possibility of uncontrolled private extraction occurring near to planned farms and causing possible quantitative or qualitative deterioration has to be taken very seriously.

2. Modern Irrigation Layout

This would include a) drilling and construction of fully equipped production wells including all pumping equipment, motors, well head installation and piping, and b) construction of lined water courses at a rate of approximately 200 metres run per ha. Here, built into the design is an extraction and main distribution system which, for a long period at least, would have to be controlled not by individual farmers, but by some project agency.

* The simplest is no more than a diversion channel leading surface water to a small cultivable area, the most complex form involving a fan of underground tunnels or galleries tapping individual springs and channelling the flow of water to a set of distributory channels serving a large area of cultivation and settlement. (47)

However, for hydrological reasons, there cannot be one major water source centrally exploited but rather, many smaller tube-wells. The control and supervisory work, even at this stage, demands a specially organised team who would have to tour the many farm groups; this complicates organisation.

The method of irrigation to be applied in this pilot project is furrow irrigation in graded borders. Furrow lengths are unlikely to exceed 50 metres in the prevailing sandy soil of this project, and application rates will be high. (51)

However, it has to be born in mind that the furrow irrigation method requires accurate soil levelling. If the soil is to be cultivated three seasons a year the levelling may have to be repeated annually. This is not a technique known to Omani farmers who normally use basin systems. It would, therefore, require a surveying team, specific machinery and experienced skilled operators.

Furrow irrigation method suits some crops such as vegetables, but not others such as wheat. Should sprinklers or trickle irrigation methods be considered for the project then a special maintenance team would have to be appointed and a special proper training programme scheduled for the settlers to enable them to meet the new technology.

3. Efficient Watering Practices

This is directly connected with the previous item. Efficient watering practices implies utilisation of the irrigation water in the most economic and profitable way. This requires 1) a proper permanent maintenance of the irrigation system 2) accurate hydrological calculation, 3) a wise management and

4) the settlers have to be trained and educated in order to obey the instructions and discipline for water distribution and allocation.

It was suggested that the settlers should construct their own reservoirs if they so wished. (52) This could be a disadvantage because firstly this will cause problems as those experienced in the Misurata development project (see chapter, 4 p. 113). Secondly, this might remove the necessity to obey the discipline of water distribution. Thirdly, the settlers might move to other changes such as erecting houses inside the farms or adapt the irrigation canals for their personal benefit.

However, the selection, training and settlement of farmers must consider those who had experience in agriculture or had been working in agriculture previously, their willingness to obey instructions and disciplines essential for the smooth running of such farms.

The stated wish of the local inhabitants to take advantage of establishing new farms and well irrigation, and establishing gardens on their own account, to the team who carried out the study, is not enough to rely on, as we can see from our other examples.

The settlers must entirely understand the government's policy and technical advice in this settlement project if there is to be the desired response to the government decisions. If, for example, they are advised to grow crop x instead of crop y, will the settlers respond or reject it because of the risk involved? Perhaps they will accept the necessity to grow crop x if they can understand the reasons for growing it and also that the government will guarantee them against crop failure.

However, beside the proposed training of settlers in modern irrigation techniques, the use of water in relation to crop growth and its seasonal activity, the offering of detailed advice on crop and livestock husbandry techniques, and the guidance of settlers in the use and proper application of all inputs, an educational programme must be introduced, together with this proposed training programme. The settlers should know how to record information and be familiar with bookkeeping.

All this throws very heavy responsibilities onto project management and in particular the extension services. This is not a generalisation but arises directly from the limitations imposed by the spatial distribution and detailed characteristics of soil and water resources available.

Drainage System:

Table No. 8-2.1.1 shows the chemical and physical analysis for a soil profile near Kamil.[53] It is obvious from the table that the grain size distribution is indicative of a very low clay content with fine sand being the dominant fraction. There is some degree of salinity, but with such a coarse textured soil salinity control under irrigation should present no problems. However, the non-installation of a drainage system could be dangerous. The question is not just leaching the salt content of the soil going to be cultivated, but also to desalt the relatively saline water and prevent the deterioration of soil structure over a period of time.

As we noted in the UAE and shall note in the case of Qatif, subsurface carbonate horizons are common in regions such as this and even free-draining gravel soils can become gleyed within a few years through over heavy water applications. The high water

Table No. 8-2.1.1 The chemical and physical analysis for a soil profile

				A	B	C	D	E	F	G
	Horizon									
	Depth (cm)			0-20	20-40	45-100				
	Colour			7,5YR66	7,5YR66	7,5YR66				
Grain size dist ibution	Clay	2u	%	7.2	9.7	18.0				
	Fine silt	2-20u	%	3.1	3.5	5.9				
	Coarse silt	20-50u	%	4.8	2.9	3.0				
	Fine sand	50-200u	%	73.7	68.0	59.5				
	Coarse sand	200-2,000 u	%	11.2	15.9	13.6				
	Carbonates		%	27.25	26.80	28.95				
	Gypsum		^{o}/oo	1.0	0.7	1.1				
Organic Matter	Organic matter		%	-	-	-				
	Carbon : C		%	0.225	-	-				
	Nitrogen : N		%	0.13	0.10	0.12				
	C/N ratio			17	-	-				
Hydrodynamics characteristics	Moisture level a pF 2.5			5.28	5.30	8.89				
	Moisture level a pF 4.2			2.81	3.12	5.02				
	Available water		%	2.47	2.18	3.87				
	P_2O_5 (Sander) ppm			25	20	10				
Base exchange complex	Ca m.e. per 100 g			1.60	1.20	0.70				
	Mg m.e. per 100 g			0.05	0.05	0.35				
	K m.e. per 100 g			0.33	0.39	0.28				
	Na m.e. per 100 g			0.10	0.13	0.31				
	Exchangeable cations:S			2.08	1.77	1.64				
	Exchange capacity:T			3.70	3.70	3.70				
	Saturation indice:S/T			-	-	-				
	PH water			8.75	8.70	8.60				
	PH KCl			8.00	8.05	7.70				
	Conductibility 25^{o}C (1/10 extract) mhos			200	219	298				
	Soluble salts:	Cl	^{o}/oo	-	-	0.32				
		CO_3H	^{o}/oo	6.60	1.90	1.80				
		SO_4	^{o}/oo	0.02	0.02	343.98				
		Ca	^{o}/oo	1.20	1.15	1.35				
		Mg	^{o}/oo	0.31	0.39	0.55				
		K	^{o}/oo	0.20	0.27	0.17				
		Na	^{o}/oo	0.08	0.12	0.32				

duty in such a climate, together with the high leaching requirement can easily create the danger of perched water tables, salinity build up and the destruction of soil.

4. Full Extension Support

It is recommended to support the proposed small intensive irrigated farms with full extension support. The latter will be operated by the service extension centre which also includes the management site, demonstration and training area, workshop etc.

Full extension support will include subsidies for providing settlers with inputs such as agricultural machinery, fertilizers, seeds, chemicals, transporting and advice. Settlers are currently subsidised through the supply of inputs and services which are provided by government at approximately half market cost; [54] similarly, the rates for machinery hire are well below operational cost.

Also settlers will have facilities for their outputs such as harvesting, grading, wrapping, packaging, transporting and marketing. These input and output facilities are typically offered by Third World countries, particularly oil producing countries. This perhaps will encourage the settlers, but -

A. Such facilities have to be backed up with other essential input factors such as:

(i) Wise management to organize and manage the soil, water, farming operation, and harvesting etc. in the best applicable way to suit the prevailing conditions in the interior;

(ii) human experience and skills such as those of agronomists, pedologists, hydrologists, and agricultural machinery drivers etc;

(iii) equipped workshops with experienced staff and the necessary spare parts in order to be able to cope with the necessary repairing and maintenance:

(iv) proper maintenance team for the project components;

(v) proper marketing processes and transporting of the agricultural productions; and

(vi) market access.

B. Two further points need to be commented on here -

(i) It is justifiable to subsidise the settlers through the supply of inputs especially in the initial stages of the project.

(ii) It is not wise to subsidise the hire of machinery at a rate well below operational costs because these machines need fuel, repair and maintenance etc. to keep them operational. The aim of self-sustained growth will be defeated if government services remove the need for private efficiency and investment.

C. The service extension centre -

(i) Since the centre of activities will not operate to its full capacity at the start, then some identification of the minimum base needs is required, from which further expansion could grow.

The same question arises here; how are the centre components to be maintained? who will pay the cost of consumed electricity and water? who will pay the cost of maintenance of the sewage system, the roads etc.? Eventually, these will either have to be met by some system of payments by settlers or perpetually financed by government.

(ii) All the settlers are Moslims; so to make the centre more attractive it is a good idea to recommend a mosque. Additionally, a police station is necessary and a telephone for communication. These social services are important and must be considered. Their influence will be similar to those described in Chapter No.5 (p.[illegible]-205)but in this case has to extend over a large area of non-contiguous groups of small farms. This again requires special design and organisation.

5. Marketing - Commercial viability

Assuming that all the farming operations in the proposed clusters of high production intensive small farms are running to plan and agricultural production is initiated there are still vital factors to consider before assessing the commercial viability of the scheme. Of these the most important is the value of the agricultural products. Those vital factors are -

First, the marketing process. As has been mentioned the establishment of farmers cooperatives under government guidance is especially important. Perishables such as vegetables are likely to feature prominantly in cropping pattern, hence successful marketing must depend in turn on timely harvest, adequate grading, wrapping, packing and rapid transport to consumer centres.

But the question arises whether such marketing processes will be acceptable to and can be carried out by the settlers. This question has arisen in many developing country situations.

Second, the prospect of those agricultural products in the markets. The two main questions concern the ability of these products to compete with other commodities available in the market and whether the return on them can cover the cost of maintenance of project components such as the service centre, all other production costs as well as providing adequate farmers' income. Input and output calculations in the report [55] showed good prospects for the project at that time, but the market situation is continuously changing and as with commodities in Oman, such as dates, fish, limes, wheat, fruits etc, the situation is far from straightforward, [56] for example the wheat area in the interior of Oman has declined as a result of the importation of Australian wheat. [57] There are several ways of dealing with the market outlet problem and most have been tried in other Arab countries, without any marked success.

(i) The government may intervene by putting a restriction on importing agricultural commodities and in this case the government has to make sure that the local production can cover the local demand. But many inhabitants will not be able to afford such commodities at the price which the government impose unless sales prices are subsidised.

(ii) Given the need for establishing the confidence of the farmers in non-traditional, commercial and improved technology farming there would be a case for government financial support initially, and to cover e.g. either unforeseeable crop failure, or the inevitable periods of needful modifications in the light of experience. It would have to be clear however that such action would be only temporary.

(iii) The impossibility of developing a large compact area given the distribution and characteristics of water and land resources and the need to involve farming families together determine that the development area will be physically fragmented. This in turn will raise all production running costs.

(iv) Given (iii) above, the need for very high value yields per hectare is very strong and little room is left for marginal failures or deficiencies. Yet the highly intensive production of specific crops properly using highly specific inputs depends on the previously traditional cultivators rapidly responding to abnormally capable advice and supervision.

B. Critical convergence and divergence points

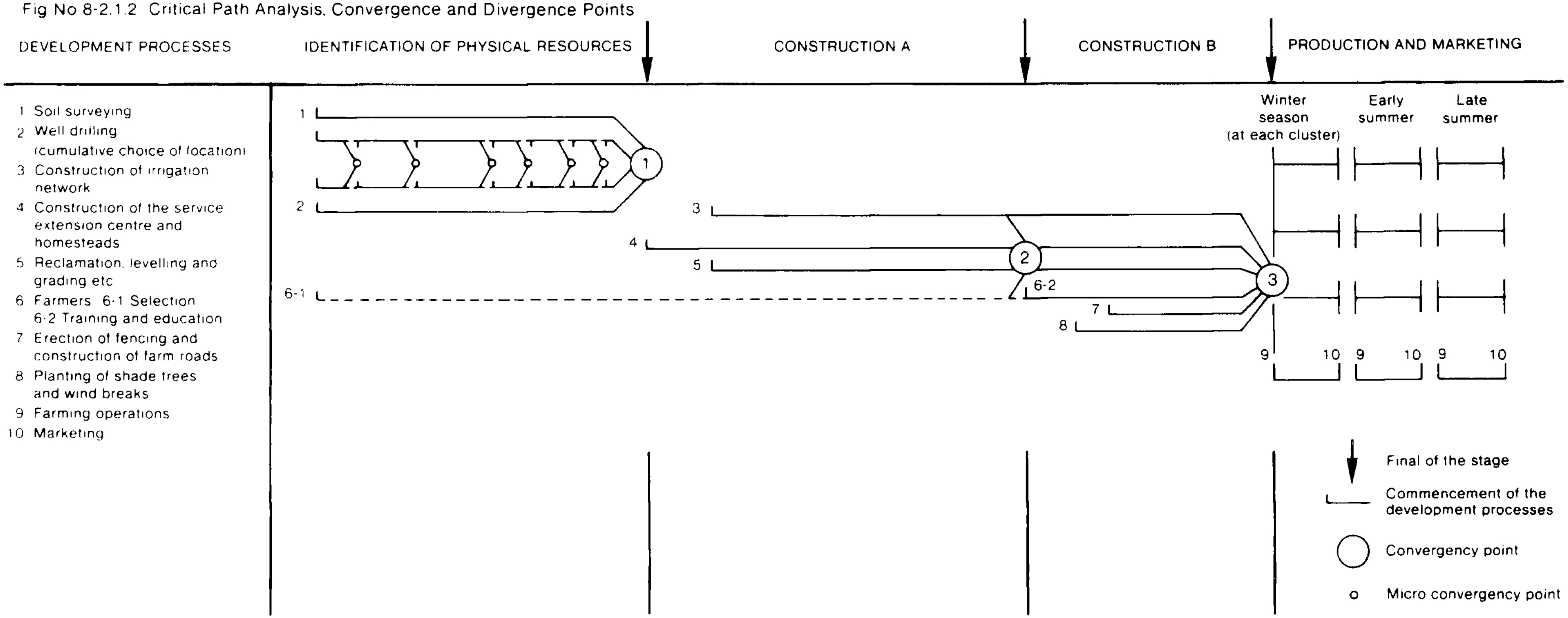
The project has to be constructed, operated, produced and commercialised through ten development processes which have to be carried out carefully; there will be interfaces between some of them and critical points at which all or some of the ten development processes must converge in order for the whole process to progress (as shown in Fig. No. 8-2.1.2).

Furthermore, within each development process there are interfaces between its component elements and also there will be critical points at which all of these component processes must converge. In order to make the analysis, identify and isolate the critical convergencies easier the stages of development are shown in Fig. No. 8-2.1.2 in four stages:-

1. Identification of physical resources.
2. Construction A, which deals with the construction of the experimental farms.
3. Construction B, which deals with the construction of the pilot project.
4. Production, which deals with the farming operations and marketing.

Some of the ten development processes 1 and 2, identification of physical resources and 6-1, the selection of farmers, must commence as soon as the government takes the decision to build the project. Development processes Nos. 3, 4 and 5 of the stage construction A are impossible to commence before the convergence point No. 1 takes place. The same is true with the development processes Nos. 6-2, 7 and 8 of the stage construction B which are impossible to commence before convergence point No.2 takes place. Again development processes Nos. 9 and 10 can not commence before convergency point No. 3 takes place. In between

Fig No 8-2.1.2 Critical Path Analysis, Convergence and Divergence Points



the development processes of each stage there is a priority of commencement. For example in the stage of identification, the first developing process to start with, after item No. 6-1, selection of farmers, should be the development process No. 1 - soil surveying for identification of cultivable land. Second one to start is the next in terms of necessity i.e. developing item No. 2, well drilling, because the location of the cultivable soil will determine the location of bore holes. Some of the developing processes have internal priority such as developing process No. 4, construction of the service extension centre before the homesteads.

1. Identification of physical resources

The farmers to be settled must be selected and known before any construction activities in the project; in the Tauorga project also these were necessary but was not carried out.

As the farmers are selected, tools, equipment, pipes, motors, machinery, construction materials etc. for soil surveying, drilling operations, construction and reclamation must be assembled on site and this means that those imported items will have already been ordered from abroad and transported from Muscat to the site; at the same time the human skills must be ready to be developed. At this point soil surveying for identification of cultivable soil and drilling operations can be started; but in arid and semi arid regions where only groundwater is available the details of geohydrological aspects become very critical. Here the difficulty which arises is whether to start processes 3 and 5 at individual sites one by one as water and soil results come in, or whether to wait for the whole programme of resource investigation to be completed before any processes 3 or 5 are started. Even the location of process 4 might have to be decided in the same way.

Again this is not a matter for generalisation. We know from other studies in Oman [58] and analogous terrain in the United Arab Emirates that soil and groundwater characteristics vary greatly over short distances and that trustworthy water borehole results in particular cannot be obtained quickly or easily. In Tauorga the process of water resource and soil survey was rendered somewhat easier by pre-existing knowledge of Tauorga spring flows, but even there the estimates of the volume of water available finally proved incorrect, and the risk of sink-hole development was greater than expected.

Here, therefore, the calculated risk of selecting locations for farm clusters one by one might have to be taken if the whole stage of identification of physical resources is not to take too long in terms of other requirements. In Fig 8-2.1.2, therefore a series of mini convergence points in processes 1 and 2, cumulatively leading to major convergence point No. 1, are shown.

2. Construction A

When the developing process No. 4 is started, following successful identification and exploitation of water and soil resources, it is recommended to start the construction as the following priority order:- housing, office, canteen because they are required as soon as activities start in the project, and then the store, workshop etc. according to their need for use and so on.

Slightly after process 4, No. 5, levelling, reclamation and grading, together with item No.3 , construction of irrigation network must start and must be performed by experienced skilled operators in order to avoid the over grading or technical mistakes as happened in some fields during levelling or during the irrigation canals construction in the Tauorga project. However, developing processes Nos. 3, 4 and 5 must converge at the same time at convergency point No. 2 otherwise stage construction B can not be started.

3. Construction B

After convergence point No. 2 is reached the experimental farm can be operated and this is the point at which development process No. 6-2, training of farmers, should start. At the same time the processes which attained convergence point No. 2 must continue, together with item No. 7, erection of fencing and construction of farm roads and item No. 8, plantation of shade trees and wind breaks, which will join the activities later, moving towards convergence point No. 3. Of course unless this convergence point takes place the next stage, production and marketing can not be started.

4. Production and Marketing

As convergence point No. 3 is reached all the agricultural machinery, tools, vehicles, seeds, fertilizers, chemicals on the one hand, and the trained settlers and the human skills on the other hand, must be on standby.

In order to start the developing process No. 9, farming operations, which include ploughing, earth embankments, pre-irrigation,* fertilizing, sowing, irrigation, chemicals and harvesting must be in hand. During this period details of marketing processes must be established, communications with the market to know the demand and price situation must take place

* It would be necessary to let the virgin soil settle before sowing or planting and the time schedule must take this into account.

as the developing process No. 10, marketing, will commence after about four months of the farming operations starting. It has to be carefully understood that as there will be three crops a year e.g. winter, early summer and late summer seasons, there will be three marketing processes in addition to marketing of the perennial crops. And thus three maximum peak periods will appear during the year e.g. harvesting of the crop, marketing processes, clearing fields of the previous crop and preparation for the next season. Any delay in the harvesting and/or the soil preparation might lead to the loss of the next season.

In this example, we cannot set the sequence of processes in real time but if implementation had been carried out this would have been necessary. This would also have pointed to the need for each set of paths within each stage and process to be exactly integrated. In the report analysed here, as with the Tauorga and U.A.E reports, there is no emphasising of how important to project success is the kind of sequence integration exposed by critical path analysis.

Several fundamental questions arise from this analysis :

1. Can Oman afford, supply or deploy all the required human skills necessary to each process?

2. Can Oman supply or afford the technology required to construct the project?

3. Can Oman import the necessary inputs such as chemicals, fertilizer and the agricultural machinery, both in total and on schedule?

4. Can Oman keep all the project components maintained?

5. Can or will the Omani cultivators operate the project as required - high production intensive farms - with limitations

on individual control of land and water?

6. Can there be sufficient continuity of expatriate skilled inputs and of Omani technical management assured for the period of years necessary for project success, other things being equal?

7. Can Oman create a commercial viability for the agriculture products?

8. Can the small family-farm production units, each of about 4 ha. and organized in relatively small clusters, ultimately sustain the cost and give returns on investment?

8-2.2 Concept of the "law of the minimum"

The identification of critical levels of individual inputs and factors which if not reached will either damage or invalidate the project. As we had seen, the project needed four stages of development processes.

Before illustrating the application of the concept of Liebig's "Law of the minimum" we have to accept that:

- various inputs in specific quantities and qualities and available to a specific schedule have to interact in order to form a developing process. Let us randomly choose any of the developing processes (shown in Fig. No. 8-2.1.2)such as item No.5 - levelling, reclamation and grading. The inputs required here are : 1. management, 2. surveying equipment, 3 surveyors, 4, transportation, 5. labourers, 6. grader, 7 land planes, 8. tractors and 9. drivers.

Assuming that all inputs, except input No. 9 because the operators are not sufficiently skilled and experienced, are perfectly provided according to technical specification, then item No. 5 will be invalid because the even field distribution of irrigation water and the application of furrow irrigation in graded borders are difficult or perhaps impossible.

Now we say "because of the deficiency or the absence of one necessary constituent such as input No. 9 (skilled experienced drivers), although all the other inputs Nos. 1-8 are present, item No. 5 (levelling, reclamation and grading) is rendered ineffective for all processes of cultivation, to the life of which that one constituent is indispensable".

Further, assuming that all, except item No. 5, of the ten developing processes are perfectly constructed according to the technical specification, the proposed project will be invalidated because of the deficiency of item No. 5 and also by its adverse effect upon other items. Item No. 5 was randomly chosen, and it should be borne in mind that the proposed project will be also invalidated even if all processes of development except item 6-2, training of farmers in new farming technology were completed.

What is now appearing, as also at Tauorga and Tawi Mileiha, is that under conditions of virgin land development in arid and semi-arid regions, especially in developing countries, the extreme criticality of those inputs associated with specifically available land and water resources must be recognised. By definition, the scientific basic data for any particular project is almost all derived from pre-feasibility resource survey and drawn from analogous regions elsewhere and is never complete or wholly accurate. The relative freedom of manoeuvre in each case is necessarily limited and the need for further adjustments in the light of monitoring results of use has to be accepted.

What matters then is whether the identification of specific minimal inputs necessary for the successful use of resources can be fed-back into (a) the statement of policy objectives (b) the general design, so that flexibility can be maximised and the project not be made too sensitive to, for example, variations in groundwater quality or soil texture.

8-2.3 Suitability and interdependence of the input factors influencing the project development processes

Suitability

The suitability of development factors involved in this settlement project (shown in table No. 8-2.3.1) is indicated by the same symbols used previously i.e. (+), (-) and (?) conducive to success, inhibiting and possibly inhibiting respectively.

The impression which the Hunting Technical Service Limited gave in the report is that all development factors will be (+) conducive to success (as shown in Table No. 8-2.3.1 column 1). But after elaborating and displaying the planned design and the expected implementation through a critical path analysis some doubts arise and we reconsider those symbols and alter some of them (as shown in the same table, column 2). Justifications and reasons for either alternatives or no change are given below for each development factor.

Construction Phase

- Project location [59] - the project location at Kamil-Alwafi as a centre for the hopeful development is logical because the area is located at a point where two wadis converge. There is theoretical evidence to suggest that plentiful underground water supplies exist at reasonable depth. The two villages themselves would provide a source of traditional farming expertise and a

Table No. 8-2.3.1 Suitability of Individual factors influencing the Project development

Construction Phase	(1)	(2)
Project location	+	+/?
Capital	+	+/?
Management	+	?
Experts	+	+
Technicians	+	+/-
Labourers	+	+
Topography	+	+/?
Well drilling	+	+
Service Extension Centre	+	+
Farms Construction	+	+/?
Farming Operation, Production and Marketing		
Investments	+	+/?
Climate	+	+/?
Soil - quality	+	+
- quantity	+	+/?
- levelling	+	+/?
Irrigation water - quality	+	+
- quantity	+	+/-
Management	+	?
Settlers	+	?/-
Skilled workers	+	+/-
Agro-technicians	+	+/-
Grouped tube wells	+	+/-
Modern Irrigation layout	+	?
Efficient watering practices	+	?
Service Extension Centre	+	-
Full Extension support	+	-
Inputs	+	+/?
Transport	+	+
Market situation	+	+/-
Commercial viability	+	?
Return	+	?
Family income	+	?
Land Tenure	+	+/-
Project components maintenance	+	?

new road links Muscat - Ibra - Kamil with the port of Sur which is only 60 km. from Kamil, this item is given (+) or (?).

- Capital - all the project costs would be met by Government revenue, most of which comes from oil export. As the Oman government is very anxious to encourage and support the creating of prosperity in the interior then theoretically no financial problems either for supply of capital or investment are expected to arise.

However, both at the time of the study and in the following period there was severe competition with other projects and other sectors for government expenditure. It is clear that in Oman's Second Development plan, 1980-85 (60) that as well as continued expenditure on oil exploration and exploitation (at a rate of over $1 million a day), industries such as copper and cement, physical infrastructure and other agricultural projects, defence and security make large demands on revenue; Oman is still a net borrower of capital. Consequently, this factor is given (+) and (?).

- Management - this would be responsible for organizing and supervising all the different resource exploitation and construction processes, together with land preparation, allocation and supervision of the production phase.

Additionally, management will have to deal with the inevitable adjustments which would have to be made during the exploitation of the natural resources. We have to assume that expatriate assistance would have to reinforce the small team of trained Omani management. Thus it is not easy to award the management (+) symbol but rather (?) at least in order that difficulties are not underestimated.

- Experts - a range of experts with different qualifications would be required to supervise the implementation of the plan which would also be carried out by different contractors. Since Oman has not the required number of experts, they will be mainly foreigners. As long as only the engineering construction matters are concerned, this factor is most likely to be as satisfactorily met as in any expatriate employing country, therefore (+).

- Technicians - many different experienced and skilled technicians would also be required to construct and run this project. It is unlikely that Oman can supply those technicians and thus they will have to be imported. To what extent the Oman government will succeed in finding and importing those different specific technicians in the right time is not certain and thus this factor will be (+) or (-).

- Labourers - although almost all the construction operations will be done mechanically, the labourers' role cannot be ignored and will be confined to manual work. No serious problems are expected to arise in terms of total availability, thus this factor is given (+).

- Topography - this is a flat area and thus no problems would arise for the use of furrow irrigation methods. Since the proposed project involves distance-separated clusters of small farms there are increased complexities and costs of constructing many relatively small gravity installation schemes and of levelling and maintaining many separate land units in suitable condition, especially if the farms contained in one cluster, or far from each other as they might be in some cases. Thus this factor is given (+) or (?).

- Well drilling - one can predict no problems for well drilling since there are several drilling companies in Oman, thus this factor is given (+), but the supply availability would depend on the phasing of operation. There remains of course the question of finding water in the required quantities.

- Service extension centre - the enormous amount of building construction in the last years attracted several contractors able to perform such construction jobs. The service extension centre is not a complex building to construct and thus there will be no problems, and will be given (+).

- Farm construction - unless these are developed by a contractor experienced in establishing such farms in an arid region, and prepared with good and acceptable designs the right machinery, equipment, human skills etc. this factor remains in doubt and thus will be given (+) or (?).

Farming operations, Production and Marketing

- Investment - (see capital p. 355)

- Climate - the seasonal temperature variation is between 20°C and 35°C in the interior, relative humidity varies from 45% to 70% and mean rainfall is 47 mm per annum. Wind blows from the Arabian Gulf and the Rub al Khali desert and the local sand dunes. No severe problems are expected to be caused by the climate for the recommended cropping pattern which includes dates, lime, alfalfa, wheat, onions, tomatoes, egg plants and ground nuts, all being suitable for the climate.

However, there are strong seasonal controls on suitable periods for sowing, and the growth of vegetable crops, particularly in the summer. The effects of climate on soil, e.g. in poor humification, and on topographical detail e.g. through wind blow and occasional stormwater erosion raise some questions. Thus this factor is given (+) or (?).

- Soil quality - soil texture and structure are suitable for the recommended cropping pattern. No problems of salinity, contrary to the Tauorga project, are expected to arise given good water management. Thus this factor is given (+).

- Soil quantity - the soils are deep and whilst there is some degree of salinity, with good irrigation management of such coarse-textured soils, salinity control under irrigation should present no problems. However, the scattered distribution of concentrations of relatively good soils necessitates the dispersed arrangement of farms, and the distance between them will increase the final cost and increase organisational problems. Thus this factor is given (+) or (?).

- Levelling - very accurate levelling is required in this project for the proposed furrow irrigation method. Whether the Omani or the imported skills can accomplish and maintain good effective levelling is not certain. Thus this factor is given (+) or (?).

- Water quality - the water quality is suitable for the cultivation of the recommended crops. It is classified (61) under C3S1*; as nothing can be done to improve this quality and as the adverse effect on production of suitable crops under reasonable management is not so significant, this factor is given (+).

- Water quantity - (see pp.337-339 and p. 353). Thus this factor is given (+) or (-).

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* High salinity, low sodium water requires adequate drainage, salinity control and salt tolerant plants.

- Management - past experience of large scale farming* in Oman has highlighted a number of technical and managerial problems. In this project involving scattered clusters of small size farms the management's job will be more difficult. Additionally the care and accuracy required in this project are demanding enough for this factor to be given (?).

- Settlers - (see pp. 339 - 340). Thus this factor is given (?) or (-).

- Skilled workers - who will carry out most of the agricultural operations. Technical problems and the limited understanding of techniques are already experienced in farming in Oman[62] and it will not be surprising if they appear again in this project. However, due to this reason and the questionable ability of many imported experts to satisfactorily apply their experience under Omani conditions and the project circumstances, and the uncertain period during which the foreigners will stay in the project, [63] will determine how successfully a suitable Omani labour force can adapt. Thus this factor is given (+) or (-).

- Agro-technicians (As mentioned above under skilled workers)

- Irrigation Sysem:

- Grouped tube wells; this factor depends on the quantity of water founded in the bore holes (see p . 337) and this cannot be known surely before actual drilling. Thus this factor is given (+) or (-).

- Modern Irrigation lay out (see pp.337-338) and thus this factor is given (?).

- Efficient watering practices (see pp.338-340) and thus this factor is given (?).

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* Examples are the large scale projects first established in Sohar by the Food Machinery corporation (USA) and also those in Dhofar province around Salalah.

- Service extension Centre - the construction and running cost is high and it is doubtful if the return from clusters of small farms could cover the production and maintenance costs. Thus this factor is given (-).

- Full extension support - it is an encouraging step to recommend firmly the establishment of this. However, Omani experience with extension services has not been very encouraging[64] Thus this factor is given (-).

- Inputs - these, which include supplying the new farmers with seeds, fertilizers, chemicals etc. would have to be part of carefully designed and implemented programmes of support which are effectively helpful but do not destroy initiative through too much subsidy; achieving a correct balance is not easy [65] and thus this factor is given (+) or (-).

- Transport - the project location is connected with Al Kamil and Al Wafi. Additionally a road is under construction which will connect the project with the coastal town of Sur. Thus no access problems are expected in this case and consequently this factor is given (+) : Freight costs could, however, be relatively high until a regular volume of freight traffic can be built up.

- Market situation ; theoretically there is a large and expanding market in the capital region. However, marketing mechanisms, both private and public, are not as highly developed in this region of Oman as further north. Nowhere are they very well developed to move locally produced agricultural commodities to the main market. [66] The competition from imported commodities is as highly price competitive as in the other situations we have considered. Thus (+) or (-).

- Commercial viability - the commercial viability of the new small farms will be entirely dependent on the ability of farmers to respond to the extension and management services promotion of intensive high value crop production, as well as on marketability. The recommendations of the Report perhaps underestimate the difficulty of producing such a response quickly so this factor is given (?).

- Returns - the returns to farmers are governed by the last two factors and project costs which they have to meet; these last cannot be known without a clear statement of what the government is prepared to do. They will also be judged by potential farming income against possible earnings outside agriculture and if they appear too low in terms of disposable household income then potentially good farmers may not be attracted; so this factor is given (?).

- Family income - because of the doubts concerning the last three factors and the availability of other income earning opportunities in Oman, the stability of the assumed new farming households cannot be assumed, therefore this factor is given (?).

- Land Tenure - as long as the owner can bequeath his land to his family according to traditional law then there will be problems of excessive land fragmentation on death. Thus this factor is given (-). Assuming government control then perhaps (+).

- Project maintenance - maintenance of this project requires the cooperation of all operators in the project, for example the maintenance of the irrigation system requires the settlers' acceptance of disciplines, experienced skill for accurate levelling and for repairing of the water courses, etc.

But as one recognises the demand shown in the critical path analysis (Fig.8-2.1.1)one realizes that this factor is likely to be given (?).

A review of the factor suitabilities, even in this summary form, clearly raises questions which can be fed-back into the design stage, in addition to the points also raised in the Report.

II Interdependence of input factors

The analysis of the suitability of input factors does not give the entire picture of prospects for the project if they are only to be treated as isolates. For this reason interdependence, the type of dominant linkages, their contribution towards agricultural development and their resulting impact as a development group have to be examined.

Construction phase, Fig. No. 8-2.3.1

1. Soil Surveying : the identification of cultivable soil will determine the locations of bore holes, i.e. where (2) well drilling will take place, regardless of the other aspects which influence the drilling. Consequently the drilling programme becomes less flexible (but see 2 below).

2. Well drilling : as it cannot be confirmed that the planned quantity of water will be obtained from any given bore hole, then the need will arise for an extensive drilling programme, the results of which will not always be positive. This will negatively influence (4) capital, the budget allocated for drilling. On the other hand (11) farm construction cannot be started, but has to be postponed until the bore holes are completely tested and ready. Equally, only if water is found to be available in the locality can any area with (1) soil resources be usable.

3. Project location : the fact that the project itself is necessarily composed of scattered cluster-farms makes (2) well drilling and (11) farm construction performance more costly and difficult and leaves no room for (5) management to concentrate efforts on one main site at the same time.

4. Capital : it is not certain that there will be no problems of finance (see p. 355) arising during the construction works e.g. (2) well drilling, (10) service extension centre and (11) farm building. In particular any factor which might lead to escalating cost might produce a cut-back by government (see p.355).

5. Management : it is doubted whether the management will be able to supervise and control every single operation, many of which will have to be executed by the unconfirmed experience of (7) technicians. Difficulties and problems for the management are expected to arise during the performance of (2) well drilling and (11) farm construction. No problems are expected to arise from (6) experts, as long as there is always contact and opinions exchanged with the management, again no problems for the management will be caused by (8) labourers because their role will be confined to this stage anyway.

6. Experts : unless there are unforseeable difficulties, no problems are expected to be caused by the experts during performance of (1) soil surveying, (2) well drilling, (10) service extension centre and (11) farm construction.

7. Technicians : no problems are expected to take place during the performance (2) well drilling because there are enough technicians experienced in drilling in Oman, the same refers to (10) the construction of the service extension centre, i.e. there are enough technicians to do this building.

8. Labourers : generally the labourers' role in this construction phase will be as simple works such as loading, unloading trucks etc. and thus the labourers' influence on (2) well drilling, (10) service extension centre and (11)

FIG.NO. 8-2.3.1 Interdependence of input factors, construction phase

	Secondary	Soil surveying	Well drilling	Project Location	Capital	Management	Experts	Technicians	Labourers	Topography	Service Extension centre	Farm Construction
Dominant		1	2	3	4	5	6	7	8	9	10	11
Soil surveying	1		?	o	o	o	o	o	o	o	o	o
Well drilling	2	o		o	?	o	o	o	o	o	o	?
Project location (scattered)	3	o	?		o	?	o	o	o	o	o	?
Capital	4	o	?	o		o	o	o	o	o	?	?
Management	5	+	?	o	o		+	?	+	o	+	?
Experts	6	+	+	o	o	o		o	o	o	+	+
Technicians	7	o	+	o	o	o	o		o	o	+	?
Labourers	8	o	+	o	o	o	o	o		o	+	+
Topography	9	+	+	o	o	o	o	o	o		o	+
Service Extension Centre	10	o	o	o	?	o	o	o	o	o		o
Farm Construction	11	o	o	o	?	o	o	o	o	o	o	

the farms construction will not be negative.

9. Topography : (see p. 356). The topography will not raise problems to (1) soil surveying (2) well drilling and (11) farms construction.

10. Service extension centre : no problems are expected to arise, but the expenditure which will be required to construct this centre is very high and may be too much for this project to justify (see pp. 343-344) and thus a large amount of the budget will be consumed by this centre, and possibly this may lead to the detriment of other development factors.

11. Farm construction : unless problems are caused by unforeseeable financial difficulties there will be no problems.

Farm Operating, Production and Marketing phase - Fig. No. 8.2.3.2

1. Investments and capital : assuming that no problems are expected to arise against application of capital and investments for supplying the necessary elements of production (18) inputs, and (19) transporting facilities, investing in (13) grouped tube wells, (14) modern irrigation lay out, paying wages for (8) management staff, (9) experts, (10) settlers, (11) skilled workers, (12) and agro-technicians; lastly in supplying the necessary equipment to keep the whole project running smoothly then (24) project components maintenance may be obtained. Hopefully, no finance problems will arise (see p. 355) and the application of capital and investment will gradually improve (3) soil quality, obtain more (7) irrigation water in quantity and consequently and hopefully establish the technical viability of the products and eventually a realistic (22) family income if marketing is successful.

2. Climate : no climatical problems will arise if the recommended cropping pattern is concerned, but there may be a danger of wind erosion when the surface is loose and dry. This will possibly form a negative dominant linkage with (5) soil levelling and consequently (3) soil quality. If no measures are taken, this problem may extend to (24) project components maintenance such as refilling of the irrigation courses and thus harming (14) modern irrigation layout and (15) efficient water practices.

3. Soil quality and 4. quantity : the sandy surface soil is easy to work for tillage and (5) soil levelling, but the question may arise of (1) amount of money to be invested for reclamation works. Both soil quantity and quality suit (14) modern irrigation, but it is doubted if (15) efficient water practices will be obtained as far as the soil quality is concerned mainly because of the settlers capability.

The nature of the soil quality and quantity associated with the dry hot climate (see pp.357-358) may negatively influence (7) irrigation water quantity, and if this will be associated with improper use of water then (6) irrigation water quality will be deteriorated by e.g. contamination. Furthermore, the soil quality may restrict the application of some (18) other inputs.

5. Soil levelling : inaccurate soil levelling by (11) skilled workers will lead to uneven distribution of irrigation water, this will disturb (7), the water quantity and leave no room for (15) efficient watering practices. Furthermore, the question of (1) investment and capital will arise as levelling may be necessary to be carried three times a year.

6. <u>Irrigation water quality and 7. quantity</u> : perhaps the water quality will make the utilization of (14) modern irrigation layout difficult. The multiple extraction points of irrigation water will negatively influence (1) investment and capital. If the irrigation water quantity is not carefully applied in each single farm, then the irrigation water balance will be disturbed in other farms and will negatively influence (6) irrigation water quality, particularly if the applied water quantity is more than necessary. Furthermore, this negatively affects (13) grouped tube wells which have to feed irrigation water for other farms and consequently (15) efficient watering practices will be impossible.

8. <u>Management</u> : it is true that the management can influence organizing, managing and supervising the works performance such as (5) soil levelling, (7) irrigation water-quantity, (18) inputs etc. But first it cannot show and watch every single operation carried out by (11) skilled workers such as (5) soil levelling, ploughing, seeding, fertilizing etc. Neither can it guarantee the arrival of (18) inputs in the right time nor can easily change (10) settlers' attitudes. And secondly it is the question of socio-economic activities management of the project which it is doubted can be carried out properly.

Thus, such problems and their impact of e.g. (19) transport and arrival of (18) inputs at the right time are out of the management's hands. Furthermore, it is doubted whether the local management knowledge will be at a reasonable standard capable of consulting and exchanging ideas with (9) experts. Consequently this will negatively affect (21) the commercial viability of the products and (24) project components maintenance.

9. Experts : their role will be as consultants and supporters for the management, but it is doubted whether their influence on (8) management will be practically valid.

10. Settlers : it is doubted whether the settlers' traditional practices will maintain (5) the soil levelled or properly apply (18) other inputs during their daily agricultural works; their unfamiliarity with disciplines and time value in general and the water allocation in particular will create problems with (7) irrigation quantity and will make (15) efficient water practices impossible and (14) modern irrigation invalidated. Consequently (21) commercial viability of the products, (22) family income and (24) project components maintenance are negatively affected. Furthermore, it is not certain whether the settlers will cultivate the farms as planned or will not adapt the installation according to their wish.

11. Skilled workers : see (5) soil levelling, (8) management, (14) modern irrigation system, (18) inputs, (19) transport etc.

12. Agro-technicians : their responsibilities are several, varied and require precise skills i.e. supervising the daily agricultural operations carried out at the site, and showing (10) settlers the suitable ways to be performed in the field such as the proper application of (18) inputs, (15) efficient water use and how to improve (3) soil quality etc. But since the agro-technicians ability to cope with these is doubted consequently (21) commercial viability and (22) family income, etc. may be negatively affected.

13. Grouped tube wells : Question of (1) investment and capital will arise because of the scattered extraction points of the irrigation water, (see also (6) quality and (7) quantity of irrigation water).

14. Modern irrigation system : is suitable as far as (5) soil levelling is concerned and to some extent will economize (7) irrigation water quantity and (15) efficient water use is possible but bearing in mind (10) settlers and (11) skilled workers, it is expected that they will negatively influence this modern irrigation system which will affect other developing factors, thus it becomes doubtful whether the application of this system will succeed.

15. Efficient water practices : this will positively influence (3) soil quality, (7) irrigation water quantity, (13) grouped tube wells and (14) modern irrigation layout, but it is doubted whether (10) settlers will obey the disciplines necessary for this efficiency and consequently (22) family income may be badly affected.

16. Shelter belt : this will mitigate the severity of (2) climate, consequently protect (3) soil quantity and (5) soil levelling against wind erosion and will keep the project components maintained against sand.

17. Service extension centre : this is an advantage for (10) settlers because they need advice, training etc. but this centre will be a heavy load for (1) investment and capital to carry, and could either severely negatively influence (22) family income and at least hinder development, or, on the other hand if services are supplied too cheaply or free for too long it will be counter-productive to the growth of self-sustaining commercial farming. Judgement here will be critical.

18. Other inputs : inputs which include (see p.360) these are applicable for (14) modern irrigation system, (15) efficient watering practices, but the doubted ability of (10) settlers

and (11) skilled workers for proper implementation and the difficulty of guaranteeing arrival of those inputs at the right time cast doubts on their viability.

19. Transport : (see p. 360), as a means of freighting, loading and unloading the agricultural commodities such as wheat, alfalfa, etc. no problems arise but when those commodities are perishable, such as fruit, vegetables and perhaps milk it is the question of skilled careful handling and delivery into market at the right time which will not be readily offered by (11) skilled workers and (10) family income will be negatively influenced.

20. Market situation : except for the government, it is out of the hands of any authority in the project to change the market situation. Thus the market situation remains as an unknown but critical element against (21) commercial viability and (22) family income particularly if marketing processes are improperly carried out

21. Commercial viability : the arrival of (18) inputs at the right time can not be guaranteed by (8) management; technical operations concerning cultivation or other matters such as (19) transport need not necessarily be performed properly by (11) skilled workers, the expected negative effect of (10) settlers attitudes and their negative effect on (14) modern irrigation layout and (15) efficient watering practices, must be borne in mind. Obviously all these problems and difficulties do not predict any commercial viability success for the products.

22. Family income : (see 21 - commercial viability), but the problem here is more dangerous as it raises the question of whether the farms may cease to be used as commercially productive units and the determination of (23) land tenure. Furthermore,

FIG. NO. 8-2.3.2

Interdependence of input factors, farm operating, production and marketing phase.

Dominant	Secondary	Investment and capital 1	Climate 2	Soil - quality 3	- quantity 4	- levelling 5	Irrigation water - quality 6	- quantity 7	Management 8	Experts 9	Settlers 10	Skilled workers 11	Agro-technicians 12	Grouped tube-wells 13	Modern irrigation layout 14	Efficient watering practices 15	Shelter belt 16	Service extension centre 17	Other inputs 18	Transport 19	Market situation 20	Commercial viability 21	Family income 22	Land tenures 23	Project maintenance 24
Investment and Capital	1		o	+	o	+	o	+	+	+	+	+	+	+	+	o	+	+	+	+	o	+	+	o	?
Climate	2	o		?	?	?	?	?	o	o	o	o	o	o	?	?	o	o	o	o	o	o	o	o	?
Soil-quality	3	?	o		o	+	-	?	o	o	o	o	o	o	+	?	o	o	?	o	o	o	o	o	o
-quantity	4	?	o	o		+	o	-	o	o	o	o	o	o	+	+	o	o	o	o	o	o	o	o	o
-levelling	5	-	o	o	o		o	?	o	o	o	o	o	o	o	-	o	o	o	o	o	o	o	o	o
Irrigation water - quality	6	o	o	o	o	o		o	o	o	o	o	o	o	?	?	o	o	o	o	o	o	o	o	o
- quantity	7	-	o	o	?	o	?		o	o	o	o	o	?	+	?	o	o	o	o	o	o	o	o	o
Management	8	+	o	o	o	+	o	+		?	+	+	+	o	+	+	o	o	o	o	o	?	o	o	?
Experts	9	+	o	o	o	o	o	o	?		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Settlers	10	o	o	o	o	?	o	?	o	o		o	o	o	-	-	o	o	-	o	o	-	?	?	?
Skilled workers	11	o	o	?	o	-	o	?	o	o	o		o	o	-	?	o	o	-	o	o	-	?	o	?
Agro-technicians	12	o	o	?	o	o	o	o	o	o	-	o		o	+	?	o	o	?	o	o	?	?	o	?
Grouped tube wells	13	?	o	o	o	o	o	?	o	o	o	o	o		o	?	o	o	o	o	o	o	o	o	o
Modern irrigation layout	14	?	o	o	o	+	o	+	o	o	o	o	o	o		+	o	o	o	o	o	o	o	o	o
Efficient watering practices	15	o	o	+	o	o	o	+	o	o	?	o	o	+	+		o	o	o	o	o	o	+/?	o	+
Shelter belt	16	o	+	+	o	+	o	o	o	o	o	o	o	o	o	o		o	o	o	o	o	o	o	+
Service extension centre	17	-	o	o	o	o	o	o	o	o	+	o	o	o	o	o	o		o	o	o	?	?	o	o
Other inputs	18	+	o	+	o	o	o	o	o	o	o	o	o	o	+	+	o	o		o	o	o	+	o	o
Transport	19	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	+		?	?	?	o	o
Market situation	20	?	o	o	o	o	o	o	o	o	?	o	o	o	o	o	o	o	o	?		-	-	o	o
Commercial viability	21	?	o	o	o	o	o	o	o	o	?	o	o	o	o	o	o	o	?	?	o		-/?	o	o
Family income	22	?	o	o	o	o	o	o	o	o	?	o	o	o	o	?	o	o	?	+	o	?		?	o
Land Tenure	23	o	o	o	o	o	o	o	o	o	+	o	o	o	o	o	o	o	o	o	o	?	?		o
Project components Maintenance	24	+	o	+	o	+	o	+	o	o	o	o	o	o	o	+	o	o	o	o	o	o	+	o	

should the return from the farm be less than the wages earned in the urban activities then settlers may abandon their farms. Experience elsewhere in Oman suggests that this is a serious possibility.

23. Land tenure : (10) settlers are to be given encouragement to become owners of farms and houses, but (21) commercial viability and (22) family income may invalidate that.

24. Project components maintenance : the project will be protected physically against wind by (16) shelter belt, but this will be invalid if the soil got too dry, which is expected to take place if (6) irrigation water application is not correct due to (10) settlers attitudes and (11) skilled workers.

To keep the project operating its components such as (3),(4) and (5) soil-quality, quantity and levelling respectively, (7) water quantity, (13) grouped tube wells, (14) modern irrigation layout, (16) shelter belt, (17) service extension centre, (18) inputs such as the machinery pool etc, will require a budget, but since (21) commercial viability and (22) high family income are dubious then from where will that budget come?

Summary and Conclusion

The government has a declared policy of encouragement and support for the rural areas in developing modern agriculture so as to slow down out-migration and create a measure of prosperity in the interior.

The study called for an investigation into the feasibility of commercial farming which is interpreted as the development, under profitable agriculture/livestock enterprises of contiguous areas.

But contiguous areas could not be found for the reasons mentioned in(pp.333-334).

Investigation of physical resources at the proposed area proved that cultivable land with utilizable water was only available in isolated and relatively small patches.

A settlement project of high production intensive clusters of small size farms based on(see pp.337-351) was recommended as a means of approaching the government's specific and general objectives.

Thus these small farms and their needs with respect to technology, skilled workers, socio-economic management, marketing etc. will have to meet the heavy responsibility of commercial viability.

Analysis of convergence and divergence points, the law of the minimum and interdependence of the development factors of the project showed that the project will be invalidated mainly by lack of experienced skilled workers, settlers' attitudes and the lack of knowledge possessed by settlers of modern cultivation , livestock and management.

If a large compact area was available then perhaps some of the costs would be reduced and some of the problems more easily overcome. However, there is no certainty that cultivators could be obtained from the local population.

These physical resources and other factors of production have to be exploited in order to meet both specific and general objectives.

The proposed scattered small size farms will depend entirely on a full time family employment since labour inputs would be reduced by suitable mechanization since there is a shortage of labourers anyway. But the new farmers would now have to be taught new non-traditional ways of farming if this was to be achieved. If this area is to be developed on the basis of its own regional resources the attractiveness of participation by local people will still mainly be controlled by events outside the region. What will matter is whether incentives and opportunities appear to be greater in the main urban areas of the capital region, and this will affect both labour and private investment.

The recommended approach, perhaps, is suitable for a country which already had knowledge and experience about technology, proper socio-economic management and flexible planning etc. but it was not suitable for Oman at this time.

In the next section a further three analogous agriculture projects in the Eastern province of Saudi Arabia will be briefly examined by applying these three evaluation criteria to see whether they have validity.

C. Saudi Arabia

8-3 Agriculture Development in the Eastern Province of Saudi Arabia

Many of the determinants of, and influences on agricultural development in the Eastern province are the same as, or similar to, these we have seen in Libya, the UAE and Oman. Here we will summarily examine the fundamental elements of three agricultural development projects to see whether the principles of problem and requirement identification which have appeared in the previous studies are also present and also to test the validity of the previous approaches. Ain Haradh was a bedouin settlement project designed for the reclamation of 4000 ha. of irrigable land from the desert. On the other hand at Al Hassa and Qatif the projects involved the up-grading of irrigation agriculture in existing large oases, involving respectively some 16,000 and 4,000 ha.[67]

1. Haradh, the Faisal Settlement Project

It lies some 180 km. south of Hofuf in the Eastern Province. Based on early studies by ARAMCO in 1963.

This project is a Bedouin settlement project developed on virgin soil to settle people of the Al Murrah tribe.* [68] The Bedouins to be settled were planned to live on farm units averaging 4 ha. plots each,[69] growing fodder crops of alfalfa, maize and sorghum, together with potatoes, vegetables and cereals, and sheep.

One thousand farms were to be established, each of which would conform to some standard cropping patterns and programmes

* Al Murrah: is the biggest tribe in the area comprising about 90 per cent of the inhabitants of the area and consequently all potential settlers may be considered as belonging to this tribe.

of husbandry.

This project was based on [70]:

1. The availability of water in the Umm ER Radhuma aquifer which underlies the whole area from the border with Iraq to the North Southward under the Rub Al Khali desert.

2. Adequate soils in the bed of the wadi Sabha. [71]

3. A source of power in the nearby gas-oil separator plant.

4. An apparent need to find new economic opportunites for the pastoral nomads of the region during a period of major socio-economic change associated with the exploitation of oil.

It was proved on a 40 ha. research station that agriculture production is possible in the area and, as a result, on June 7, 1966 WAKUTI was given a contract to establish an irrigation and drainage project. [72]

After completion of installations in 1971 the Saudi authorities undertook to implement agricultural production on the original terms but this has not proved possible. The government is now attempting to develop the area as a joint commercial enterprise with foreign investment. [73] It is hoping to establish a herd of 8,000 dairy cattle and to concentrate on forage crops, milk and meat production, [74] a complete change from the original objective, but the project is not yet completely operational and virtually all the investment in gravity distribution system has been wasted.

Analysis

The abandoning of the original project may be attributed to several factors, the most important of which was undoubtedly the attitude of the nomadic Bedouin towards settled agriculture.

Their reluctance to become committed to this project may be summarised as follows:- (75)

1. Although 96% of those previously questioned indicated that they were willing to become farmers, many of them did not realise that irrigated cultivation and intensive livestock production demanded a permanent labour input; they did not really know what agriculture involved. Moreover, nearly half of those questioned were under 15 years of age and could be expected to leave the land in any case.

2. The change from pastoralism to permanent agriculture and livestock rearing was too sudden and complete; it might possibly have succeeded if plans had been made to train some settlers selectively in a gradual and longer term transition.

3. There were certain activities such as handling manure, cutting hoofs and looking after poultry, which by tradition they refused to tackle.

4. The planned communities were drawn from different tribal groups, thus breaking the social cohesion of the tribe.

5. They were largely illiterate and unable to cope with new technology, instructions or record keeping.

Another factor related to the potential market for farm products. The Eastern province was already provided for by the farms of Hassa and Qatif and the Riyadh area by those of Kharj and Qassim - and of course by cheap imports. The only remaining markets for the Haradh farmers were in the west where the areas around Mecca and Jedda could not provide sufficient foodstuffs for local consumption. This involved transport costs over a distance of 1200-1400 km, so that without the help of heavy

Government support the farms could not be expected to be profitable.

If we now apply to the Haradh case the same evaluation criteria that we have previously used we find that the same types of analytical results appear. For example, in terms of the Law of the Minimum, one essential input was not available i.e. the potential settlers. By 1974 it was already clear that the Al Murrah would not voluntarily become cultivators. Secondly, in our use of critical path analysis we recognised the critical nature of time lapse between the conception of a project and its readiness for a production phase. At Haradh it is clear that whilst in the early 1960's it was not unreasonable to assume that pastoralists could slowly be educated to become small-scale commercial cultivators, however the 1970's in the Eastern Province of Saudi Arabia was a period in which so many opportunities for well paid unskilled or semi-skilled employment appeared outside agriculture that the attractiveness of becoming a farmer settler on the terms described decreased considerable.

Other elements of interdependence etc. could also be noted but it is sufficient to note that the points made above could have been paid more attention to in the design and recommendation stages if their critical nature had been identified at an early time.

2. The Al Hassa

The Al Hassa Oasis is one of the oldest settlements in the Middle East, and was already inhabited about 5000 years ago. It covers an area of about 20,000 ha., it is "L" shaped and extends about 16 km. west-east and about 20 km. north-south. (76)

The capital is Hofuf which lies at the meeting points of the two axes of the L.

It is necessary here to distinguish two main phases i.e. before development and after development.

Before Development : large areas of cultivable land had been lost to cultivation by encroaching sand dunes which, for example, are moving at a speed of 10 m per annum for a dune with an average height of 10 m.[77] Additionally, land was being lost as the result of waterlogging and increasing soil salinity, caused mainly by the application of freely flowing water by traditional means such as "saih" irrigation in which water is allowed to flow by gravity into gardens and fields, in others requiring a shadouf to lift water onto the cultivated areas "Mugharaf"irrigation.[78]

By 1950 the size of the cultivated areas had shrunk from 20,000 ha. to 12,000 ha. and by 1965 only 8,000 ha. were occupied with 4,000 ha. imperfectly irrigated.[79]

Development project : In the 1960's the Saudi Arabian Government formed the Hassa Irrigation and Development Authority and embarked on a major irrigation and drainage programme with the intention of halting sand encroachment and reclaiming 12,000 ha. of cultivable land to give some 20,000 ha. The irrigation and drainage scheme, designed and carried out by international consultants, commenced in 1963 and was completed in 1971.[80]

Analysis

The most important problem is concerned with the efficient use of water. In Al Hassa it was possible to concentrate all water extraction at a relatively small number of spring locations and therefore to bring water extraction and distribution under central control.

The quality of the irrigation water i.e. E.C.2.38 mmhos/cm [81] requires that it must be used in a carefully monitored and intelligent manner. Some of the highly technical consultants' reports on the best way to proceed have probably been so complex and sophisticated as to have little practical application to the advisory services and farmers involved.

A fundamental problem results from the changeover from the original traditional water distribution systemswhich have had to be forfeited and the peasant introduced to the modern 24 hours supply which requires a constant supervision team. However the technical rationalisation of the control of water quality, application and drainage has not been completely possible because of the survival of a great variety in size and shape and type of crops of individual plots in any one irrigation sector. [82] Further indiscriminate oil drilling near the oasis, effluent discharge by the growing urban population, leaching and possibly recycling of fertilizers are leading to a deterioration in the quality of the water. [83]

The total quantity of water thought to be available at the outset of the scheme has also proved to be inadequate for the projected reclamation. Leaching loss of up to 36% of the water applied may have to be accepted to prevent salt accumulation in the soil. In addition there are increasing and conflicting demands for water from non-agricultural consumers : industry, oil well injection and urban populations with rising living standards. It is now unlikely that the original target of 20,000 ha. of irrigated land will be achieved. The water at present available is only sufficient to irrigate 12,000 ha. in winter and 8,000 in summer. [84]

Let us now apply to the Al Hassa case the same evaluation criteria which we have earlier used. For example, in terms of the interdependence of the input factors we can identify a dominant positive linkage of water use, in other words the water use must be very efficient. Firstly, in terms of water quality, required standards could not be maintained given the very great variability of water application efficiency by landholders and cultivators who have only partially changed their traditional techniques. Secondly, in terms of water quantity, the projected target was not met, also because the management is not able to allocate everywhere the right volume of water due to the great variety in size and shape and type of crops of individual plots in any one irrigation sector; this has been made worse by the growth of non-agricultural demands.

In our use of critical path analysis we recognized the necessity of several input factors to be introduced into the operation at specific times in order to form necessary convergence points at specific times. At Al Hassa whilst the path of technical construction and installation of hypothetically efficient water extraction, distribution and drainage systems was completed on schedule, there was no convergence with any possible realignment of cropped areas or training of cultivators in efficient water and land use. Without such a convergence of two necessary paths, the objectives could not be reached.

The other elements of evaluation criteria could also be applied but it is sufficient to note here that the analytical approaches illustrated above could have been fed into the design stage.

3. Qatif

The main oasis stretches for about 12 km along the Gulf shore and averages 2 km in width, [85] Qatif City, according to tradition, being established at its present coastal site during the eighth century A.D. by people moving from the encroaching sand dunes which threaten the oasis from the west. [86] However, Qatif City maintained a thriving export trade in dates and date products from the oasis into the twentieth century. But the application of freely flowing water of between 2.8 and 4 mmhos/cm by traditional means of irrigation, to small basin irrigation, using a rapidly increasing number of shallow wells but not using drainage, rapidly led to a build up of soil salinity and water-logging and producing sebkha swamps within the oasis. By the 1950's this had led to the abandonment of many date-gardens, a fall in the productivity of others and to widespread malaria. [87]

In 1955 ARAMCO produced for the Kingdom the first study of drainage requirements and in 1964 an irrigation plan for the oasis. [88]

The 1961 government proposals for the establishment of an Experimental Farm and Agricultural Centre were followed up by a series of consultants surveys and by 1964 a new main drainage system for some 4000 ha. had been installed. [89] By 1970 the basic physical infrastructure for successful irrigation agriculture seemed to have been established, [90] but as we shall see the proper utilisation of this infrastructure has been more difficult.

Analysis

The first technical necessity was to establish general parameters within which available groundwater and soil could properly be utilized; [91] this task was far from being obtained.

The surface horizons are very permeable, but underlain by a cemented calcareous hardpan at a depth of 50 to 200 cm below the surface, thus downward drainage is all too often severely impeded and even with installed drainage the groundwater table lies between 20 and 60 cm below the surface. (92)

There is the difficulty of introducing a structured network of drainage system at all levels from field to oasis, without which poorly managed land adversely affects the soil-water balance everywhere. (93) Unlike Al Hassa, it has not been possible to replace the hundreds of individually controlled wells by a centralised water extraction system and therefore impossible to devise an integrated irrigation distribution system for the whole oasis, given the great number and wide distribution of ground extraction points. However, the above mentioned problems are only few among several problems which really do exist.

Again, we apply to the Qatif case the same evaluation criteria. For example, in terms of interdependence of the input factors of irrigation water and management we find the same type of analytical result which appeared in the Al Hassa case, but with an additional difficulty, which did not appear there i.e. irrigation water has to be extracted from multiple points which require complex supervision from the points of extraction all the way through to the plots. Consequently, a dominant negative linkage has to be ascribed to the input of water. A further example of interdependence appears with drainage. Whilst a government agency could instal basic main drains in the oasis, the linking of these with the existing irrigated plots was and is technically difficult given the high groundwater table and critically variable details of soils and topography. Further, a motivation for using the new drainage system depended on the attitude taken by landowners and cultivators to cultivation. In Qatif, for thirty years, the growth nearby of urban and industrial activities (for example in Dammam, Al-Khobar, Ras Tamuna etc.) theoretically created a market for Qatif oasis potential production. In fact what this did do was to divert almost all energy, investment and interest away from the agricultural sector to others. Here one can see the necessity for examining changes over time of the various interdependence factors.

Other analytical elements and evaluation of criteria could be identified, but it is worth noting that the negativity of these and other points could have been at least minimized if they had been identified and paid more attention to in the earlier stages.

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CHAPTER NINE

Conclusion

Agriculture development can be either on virgin land, horizontal expansion, or on land improvement of existing farms, vertical expansion. The former means increasing, through land reclamation, the number of hectares under cultivation, and implies essentially expansion and areal extension; the only fundamental element of transformation is that transforming the land factor. On the other hand, the latter implies changing what farming already exists in order to obtain higher productivity (variously measured) and therefore also implies intensification of production; here transformation fundamentally means changing above all farmers' attitudes and farming systems.

In this thesis we are chiefly concerned with virgin land development projects, noting that some of these involve the expansion from pre-existing utilized areas. As we have seen through the analysis of these six agricultural projects each one of them has unique characteristics, but they are also basically similar, their common characteristics being:-

A) The use of imported technology and know-how to identify and exploit previously under-utilized resources. These resources were under-utilized because traditional local technology was not capable of identifying and evaluating them. At Haradh we find an example of completely new appreciation of the irrigated agricultural potential of an area previously only used by tribal groups for grazing. At Tauorga project where, except for about 5% of the present project area which used to be seasonally cultivated, the pre-project land use was entirely pastoral. The Al-Hassa Oasis, on the other hand, was inhabited at the time of Moses, but where again during the 1960's, new technology made it possible to consider an expansion of the irrigated area from 8,000 to 20,000 ha. etc.

However, this in turn means that while in such virgin land projects there are minimal problems of transforming existing agricultural systems, it also means that in extreme cases there is also an absence of local experience of irrigation agriculture. This latter is obviously not strictly true of projects involving the expansion of existing cultivation.

B) The common physical characteristics of such under-utilized resources of water and land are such as to require very specific technological demands because they are usually in environmentally marginal areas. Their common characteristics are summarized below:-

1) Restricted choice of location: The spatial location of usable but previously unused soil and water is often critical, as e.g. at the Kamil Al Wafi project in Oman, where wells have to be drilled in the small dispersed areas where cultivable soil can be found (see pp.346-347). Another example can be found in the Tawi Mileiha project. There the risk of flooding was predicted during the pre-feasibility study, and though the establishment of flood prevention barriers would increase the project expenditure, this location was accepted because there was no alternative development area.

2) Cultivation in the arid and semi-arid areas of the Middle East depends upon the use of either diverted river water in the case of riparian states such as Iraq and Egypt or groundwater. In this thesis we limit attention to projects dependent on groundwater availability for irrigation, but the quantity and quality of water available is a function of

highly complex geohydrology and geomorphology. Consequently, at the pre-feasibility and feasibility study stages, it is very difficult to accurately measure the quantity and quality of potential water supply. An example of this is found in Al Hassa Oasis where the average annual water flow available in December 1979 was between 60-80 million cu.m. less than the 220 million cu.m. flow estimated in 1963. (1) Differences between estimated and actual water flows were also noted at the Tauorga project (see pp.66-64). General water quality itself is not necessarily stable with time. For example, contamination of surface aquifers by the percolation of water used in irrigation and charged with soluble salts may occur (see pp.316&320). Pollution can be caused by the oil industries and urban effluent such as in the Eastern province of Saudi Arabia. Contamination by the movement inland of the sea water/fresh water interface through over-pumping on land has been recorded in coastal Tripoli (2) and the Batinah in Oman.

Even the choice of irrigation technology is restricted by water quality (see pp.71-72). Saline and high temperature water produces mechanical and corrosion problems in overhead sprinkler systems, but even where this system could be applied with low salinity water, high carbonate content water - common in the Middle East, can produce leaf surface damage to plants.

3) Soil: Salinity, which is a common phenomenon in arid and semi-arid regions (see p. 51), requires leaching which can be up to 35% and even 50% (see p .77) of the total water application. There are critical rates for soil complexes in each specific project area and also variations within each project area. Secondly, the soils have generally low inherent

fertility, low organic and nutrient content, especially of nitrogen, poorly developed textures and a relatively high content of free carbonate and salts, yet can vary widely over short distances.

These characteristics, which in themselves are only plant-growth inhibiting because of the poor availability of plant nutrients, become critical when irrigation is introduced.

Water - application has to be heavy because of high evapotranspiration rates, this being partly because of physio-chemical reactions and partly because of the mechanical concentration below the cultivation levels of the finer silt and clay elements, which accelerates a decline in soil permeability. Impaired drainage in turn leads, at one extreme, to waterlogging and swamp conditions such as at Qatif Oasis, at another, to the build-up of salts even where soil and ground water salinity is naturally fairly low.

Crop - choice is therefore strongly influenced by the need for good ecological irrigation, for improvement of the fertility and water holding, soil management as well as by economic considerations, and the former may be dominant; this strictly is what is required at Qatif. Therefore, not only are basic, very detailed soil surveys needed, but the best system of soil and water management has to be sought. For example, the very careful choice of irrigation systems e.g. over-head or surface, including detailed techniques,maintenance, cropping patterns, fertilizer application, selection of crops etc. Drainage difficulties are not only a function of soil properties but are increased by high demand, not only by plants, but also for leaching. In areas where previously utilized water and soil resources are to be exploited even very intensive resource surveys do not supply all the data necessary for predicting precisely soil/water behaviour under irrigation and therefore there will be required close technical supervision at all the project development processes, even at production stage (see pp.161&165) and monitoring over periods.

4) Climate: the main features in mid-latitude arid regions are the high temperatures of summer associated with a wide annual and diurnal range. In winter, as at Tauorga temperature can fall to freezing point while in summer temperatures of 40-42^{o}C are not uncommon (see p. 49). High insolation and high transpiration strain the range of crops or livestock to be grown or kept respectively. Wind has the double effect of increasing evapotranspiration causing water loss, and mechanically causing damage to crops and trees. High air temperatures can inhibit seed germination and can also adversely affect animal metabolism; high soil temperatures inhibit humification in soil and prevent seed germination. High temperature and humidity, which are particularly associated with irrigated mixed trees and crops, are also conducive to pests and disease proliferation (see pp.241-242). A further problem can be shifting sands, consequently wind breaks such as in Al Hassa and Tauorga(see pp.378& 84) became not only necessary, but also compulsory. The described harsh physical factors severely limit the range of crops which can be cultivated or the livestock which can be reared. Crops and animals then must be carefully selected, not randomly as at Tauorga (see p. 230), and only when these environmental requirements are satisfied can it be decided which cropping or animal programme is commercially viable. Furthermore, these harsh physical factors influence the structure

and installation of the project planning. Consequently, for example, the irrigation canals and the drainage ditches have to be large in capacity, which increased the cost, in Tauorga about 84% of the total expenditure of phase 2 - stage 2 (see Table No. 4.1.1), and resulted in a waste of cultivable areas.

One can say therefore that, on one hand the agricultural potential in these investigated projects does exist. On the other hand these physical factors with their severe restrictions and their specific characteristics leave no room for manoeuvre, and in combination they create a unique situation in each case. Virgin land projects in such regions involve the creation of a critically sensitive ecological environment for farming placing the responsibility of exploitation in hazardous environments on the human factor which becomes the key variable.

C) Most important is how these hazardous physical factors are dealt with by specific groups of people at different levels and the result of the interdependence of physical factors with the economic, social and organizational factors of production at various levels of survey, plan, design, operation, maintenance, etc. The common major characteristics of the production factors deployed in the cases studied to match the exploitation of those described harsh physical factors can be summarized as follows:-

1) A relative abundance of capital, as with Libya and Saudi Arabia, so that no problem of finance arose during the project development processes, their operation and maintenance. Furthermore, return on capital was not generally regarded as of prime importance; subsidies, free interest loans, are

being generously given (see Table 1.10 and pp.20-23) and capital apparently having been written off. However, by so doing the opportunity of creating an investment generator is destroyed (see p 206). Furthermore, it must be noted that such governments are prepared to accept this situation as they consider that these expenditures will lead, at least, to provide even a minimum of social services for and dispersal of oil generated income to the involved inhabitants.

2) Settlers/Agricultural workers: whilst we have noted that the successful exploitation of hazardous environmental resources throws critical responsibility onto the users of the land, we also have to note that the implications of this were not properly followed up. In none of the projects were settlers or agricultural workers selected or identified beforehand, neither were the essential education and training programmes needed for the future operations of the highly designed technological farms carried out, except in Tauorga and even there very little was actually done (see pp.232-233). These settlers/agricultural workers with their background of traditional cultivation were to be transferred immediately to the modern farms causing a lot of difficulties. It is not merely the question of finding sufficient numbers of inhabitants to be settled, but rather their attitudes in wanting to be farmers (see pp.376-377) and skilled irrigation farmers at that.

3) Know-how, technicians and technology: even accepting design problems, we find, except at Al Hassa, Haradh and Qatif which were constructed by European firms, the rest of the projects were not properly constructed. The regional and national shortages of skills showed up also in difficulties and

problems of operating and maintaining all these projects by indigenous workers after their construction "the scale of current engineering projects in the Arab world is truly monumental, yet very little is known, in the region, about the economics, the technology, or the implications of these major schemes designed and executed by international engineering firms as turn-key projects."(3) However, in such projects and in many non-agricultural ones, the continuous need for skilled technicians and supervision cannot permanently be met by turnkey contracts. In the case studies, for example, the required accurate levelling, specific depth of sowing and ploughing and even distribution of fertilizer spreading, etc. (see Chapter 5-1.3) could not be carried out in Tauorga because there were too few indigenous technicians and no likelihood of these appearing (see Table Nos.4.3.1 & 4.3.2).

4) Management: management definition and duties were shown in p. 107 . It must be emphasized that seasonal and daily agricultural and non-agricultural external connections and internal operations in such projects require very high levels of accurate assessment. These can only be controlled by careful management which is capable of dealing with all the project activities including those internal and external, national and abroad. The irrigation water in the Tauorga project, for example, has to be brought from a single source into the Djosas through the irrigation system (see p p.71-75) Tauorga project is divided into different sizes of hoshas; these being sub-divided into different sizes of katas and these are divided into different sizes of djosas. All are cultivated with different crops. Due to this variety of

sizes and crops a central management for distributing the right volume of water from springs to the Djosa is essential. This requires a very well experienced team which comprises: Organisation, advisers, supervisers, technicians, skilled workers and watchmen for the main irrigation canal gates, reservoirs, sub-main irrigation canal gates etc. This matter will be more complicated in Qatif, for example, where there are multiple extraction points of irrigation water. However, this is only the requirement for the irrigation system: still other different teams for drainage, workshop, cultivation, advisory, transporting, marketing etc. were required. Except in Tauorga where these teams were formed, although lacking in numbers and experience, elsewhere they rarely exist. Even more lacking was the management necessary for integrating all the technological, social and economic affairs of the project. Such management would also have to be capable of absorbing all the feedbacks from monitoring systems and, where necessary, responding and adapting to necessary changes.

Unfortunately, as we have seen, not even preparation for such requirements took place and thus neither the external nor the internal activities of the Tauorga project could be operated as planned. Firstly, the existence of a rigid routine in administration in the construction (see pp.210-211) and the reclamatory cultivation (see p. 116). Secondly, when the first technical necessity of establishing general parameters within which available water and soils could be properly utilized was established, the management was not able to cope with the requirements because of its low quality. For example, in the Tauorga project(see pp.222-223) the sink holes phenomenon, was predicted as being a hazard during the pre-feasibility study but it became more critical than earlier predicted (see p.217) partly because of managerial deficits in technical control and then a lack of ability quickly to respond correctly.

In none of these projects was the quality and the power or responsibility of the management determined or identified.

- Management quality: Whilst at one level of classification all the development projects considered, with the exception of Al Hassa and Qatif were similar i.e. the establishment of viable commercial farming households on irrigated reclaimed arid zone land, at an operational level we have noted the importance of apparently minor, but critical, differences in the balance of interdependence of input factors as we have seen in Chapter 7 (pp.288-310) and Chapter 8 (pp.328-330 & 363-371). Management quality must be very high if the critically unique needs of each such project are to be satisfactorily identified and responded to: there is no such thing as a routine standard approach applicable everywhere.

- Management power or responsibility: given the pioneering character of most of the projects, both in respect of the resources to be exploited and the communities involved, it is remarkable that there was no clear statement of the responsibility given to managements fully to control events. For example, management was allocated no control over land occupance to insist that land was being used as planned (see pp.112-114) and no clear legislation or regulation relating to the prevention of subdivision of holdings through inheritance (see p.114).

At a strategic level, the need for establishing clear management powers for major decision making e.g. at Tauorga whether or not to proceed with central village construction, or at Al Hassa, how to allocate rationally the reduced volume of water actually available by 1977 compared with that on which the plan was based in 1963. Yet in such projects the probability of discrepancies appearing between the planned elements and what becomes necessary is high and the need for clear decision making authority is therefore great.

5) Agriculture Policy: it is noticeable that there was an absence of clarity and precision in the statements of projects' objectives and this adversely affected the validity of policies.

A. Absence of clarity of Objectives: it has been noted that all these projects had multi-objectives which appeared impressive in total (see p. 154), but there was no single clear over-riding objective stated. In these projects, therefore, the question of conflict of priority could not be resolved, for example between the objectives of settlement, resource exploitation, maximising agricultural production requirements, the regional improvement of socio-economic and cultural life. Each one of these could have been met in isolation but when assembled without any stated priority given, inevitably produced conflicts of interest. For example, at Mileiha and Haradh, the decisions to establish small family based holdings made it actually impossible to maximise agricultural production - even to obtain much production at all. At Al Hassa the most effective use of water resources has been severely and adversely affected by the survival of the traditional pattern and layout of holdings.

Every development project will contain several facets and we have already emphasized the point that there will be minimal levels of and interdependence between input factors (see chapter 7.2 and 7.3). Further, there must be an early very clear identification of the interdependence and incompatibilities between the various facets of policy objectives. In other words, there should be a feedback to the statement of objectives from the stages of feasibility study and even from the implementation stage. To some extent this may have occurred in the Oman case in that the recommendations were not implemented, but in all the others changes in policy objective following project experience were confused and never really defined.

B. Validity of Objectives: we have seen in the case-studies that the validity of stated objectives was destroyed or damaged by some groups of defects.

1. Foreseeable defects - there could have been avoided, but unfortunately were not, for example:

(i) Social factors which were defectively surveyed or considered before the project was constructed, such as in the Haradh project which was constructed on the basis of incorrect assumption of the attitudes of the proposed settlers (see p.376) or, as at Tauorga (see p. 269) where the numbers of potential workers were greatly over-estimated.

(ii) Table No. 6.7.1 shows a comparison between two technological approaches(see pp.256-257). A fairly high technological approach was chosen in all these projects, but the very low level of capability of workers to apply such technology was completely overlooked. Approaches which had been developed and proved within the context of technologically developed society, where they were related to the cultural heritage and resource endowments, had not the same beneficial effects when applied to an under-developed country.

(iii) Even where the validity of planned project objectives is satisfactory using internal criteria and in isolation, this may be reduced if not co-ordinated with those of other projects. The competition for groundwater between the Tauorga project and others in the same region was noted on (pp.244-246). Behind the project distribution of farms and houses lies a damaging process of competition for scarce technical and managerial skill. Other examples can be found in every developing country.

2. Unforeseeable defects - this is a category which is not very simple to define because it involves the central question of forecast accuracy. First, we can assume that the accuracy of forecasting the project outcomes will decline, the longer the period of time concerned.

(i) Factors which change with time: In all the case-study countries' predictions of the effects on national and regional societies and economies of large but increasingly irregular increases in oil revenue were very difficult. While the oil era has brought with it government investment in agriculture (see pp.16-17 & Chapter 4.1) expanding markets for agricultural products and an exposure to new technology, as well as creating local private capital, it has also created vast opportunity differentials which have demoted agriculture as a rewarding sector (see p.383). There has been a vast growth in urban job opportunities which compete overwhelmingly with farming, particularly for the young and skilled workers. The attraction of industry and commerce for investment, both of money and attention by the leading land owning families puts agricultural development in the private sector at a disadvantage. This factor played a major role at the Haradh project where it added to the problems associated with the cultural attitudes of the potential settlers. In the Tawi Mileiha project, planned in 1966/67, the effect of the rise in per capita income, first in Abu Dhabi to the highest in the world by 1968, and later affecting the whole UAE was not, and in the circumstances could not be fully assessed for its implications. Whilst the growing urban markets for agricultural products were identifiable, the very rapid effects on income opportunity, particularly as they related to the immediate locality and to Sharjah (the state concerned) in the period before the creation of the UAE in 1971 meant only at a very general level could the implication for Mileiha and Haradh be forecast.

(ii) The long period between the pre-feasibility study of the project and its final completion, such as the Tauorga project i.e. from 1960 until December 1977 and yet not completed, during which many factors such as the prices of inputs and outputs, style of life etc. changed. One question which arises here is the extent to which the degree of changes in external factors outside the control of the project, or even of Libya, e.g. the costs and availability of imported plant and technology, is a function of time. The longer the period between policy formulation and project completed the more unforeseeable become such changes. In none of the case-studies does it appear that this increasing lack of control was appreciated and therefore the effect of delay at decision-making, or implementation stages was never fully realised.

(iii) Political factors: The need in Libya for foreign labourers and technicians was assumed to be met by Egypt and Tunisia. However, labour was sometimes available and sometimes not, depending upon the changing relationships between Libya and these two countries (see p. 224).

The sometimes difficult relationship between Libya and the developed countries also created difficulties in importing technology, seeds, fertilizer etc. Such factors again could not be built completely into the forecast or forward planning assumption on which the validity of the objectives were based.

So far in this conclusion we have brought together many of the reasons why in projects examined there appeared a wide gap between plan and actuality. What has appeared in the thesis are some common patterns of these reasons for this discrepancy, the patterns appearing from the analyses made in Chapters 6 and 7.

The Tauorga and the Mileiha projects were investigated and reviewed fundamentally and in terms of general principle why such discrepancies between planned and actuality took place. First we applied a type of critical path analysis, secondly, the concept of the "law of the minimum", thirdly, we used a matrix analysis to measure the suitability and interdependence of the input factors involved in these project development.

- In any project there will necessarily be a sequential flow of specific technical and other inputs like a rope of various strands of operational sequences and there will be critical convergence and divergence points limited to real time points and periods. If even one point was not met, the project moved out of control and the result was a wasting of time and money (see Chapter 7 pp.263-271 and Chapter 8 pp.321-323 & 346-350) and a major departure from the project objectives.

- By enlarging the concept of Liebig's "law of the minimum" it was possible to identify four different degrees of critical problems in the Tauorga project (see Chapter 7 pp. 271-280) and a very serious problem in the Mileiha project (see Chapter 8 pp.324) caused by the deficiency or absence of one necessary constituent even though all others were present.

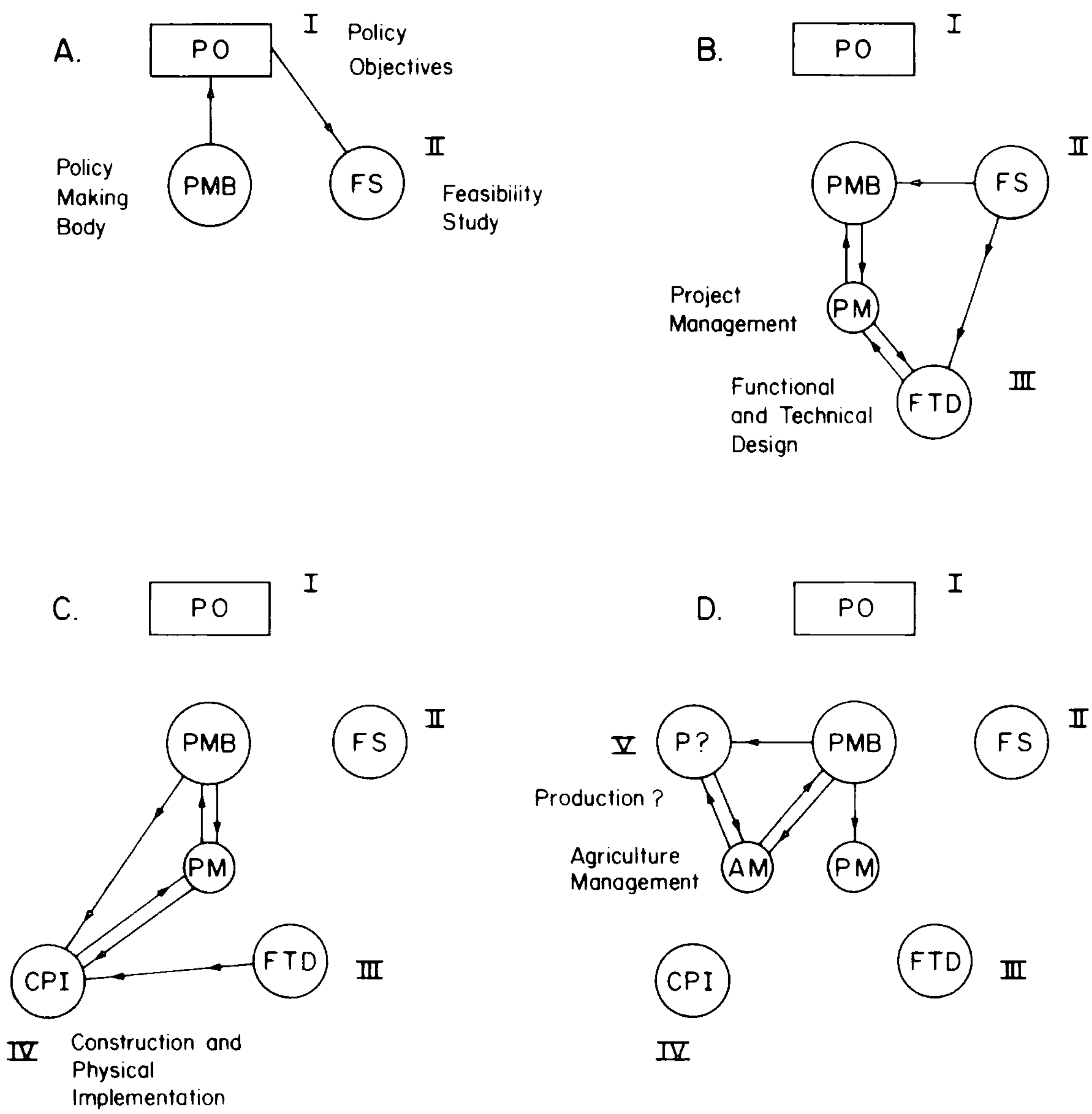
- The measure of how conducive to success of a project are the input factors cannot be based on treating each in an isolated fashion. The vital and conclusive fact in determining the success or failure of development is the interdependence of these input factors according to whether the dominant linkage will be positive or negative (see Chapters 7.3 and 8-1.3 and 8-2.3). Furthermore, these three approaches were applied briefly to analyse further three analogous projects (see Chapter 8.3) to see whether they had a more general validity. As the result was positive, we turned to analyse, using the Kamil Al Wafi case in Oman, a recommended plan which was not implemented to see if these three approaches were also valid.

It appeared from analysis that if this project had been implemented then it would have been bounded by exactly the same parameters which were prevailing in the other five analysed projects.

Can we then say that the application of these approaches at early development phases could reduce the danger of failure of planned projects?

We can illustrate the application of these approaches by reference to the main sequence of processes involved in project development as schematically indicated in Fig.9.1.A-D. Central to all projects is the Policy Making Body (PMB) which is necessarily responsible for laying down and changing general Policy Objectives (PO). Once general Policy Objectives (I) are stated these become the terms of reference for Feasibility Studies (II). The decision whether or not to proceed with any project has to be taken by the (PMB). What then is essential is that the Feasibility Study (FS) should indicate very clearly (a) whether all or some of the objectives can be achieved (b) the criticalities involved in such achievement. For example, in Fig. 9.1A the PMB lays down the PO(I). These are fed forward to the FS(II) and at this point the three approaches developed in this thesis can be applied so as to give a feed-back to the PMB, this in order to validate or invalidate all or part of the objectives. If we applied this to the cases studied what do we find? In Tauorga, for example, the Feasibility Study showed that, at that time, there existed a hypothetical labour pool from which settlers and permanent agricultural labourers could be drawn, in other words, the law of the minimum was apparently satisfied here. However, the Feasibility Study also showed (but did not emphasize) that the detailed characteristics of terrain, soil and water resources were such as to require very

Fig 9.1 SCHEMATIC SEQUENCE OF PROJECT DEVELOPMENT



careful and precise operations in construction, land preparation and production use. If the interdependence between these factors and a high level of skill at all levels from management to work on the land had been identified then, e.g. the critical need for employing the <u>best</u> contractors would have been fed back to the PMB and the crucial need for training the indigenous labour force would have been fed forward to the Design stage (III) see Fig. 9.1.B. The PMB at this stage could have retained unchanged the PO but would then have to instruct that the next operations based on the FS would commence, for this purpose setting up a Project Management PM which would commission Functional and Technical design (III).

The terms of reference for Project Management could then have contained the refined version of PO together with instructions derived from the FS. Project Management would then, hypothetically, have been able to give more detailed instructions to the design stage.

At the Functional and Technical Design Stage, FTD Stage (III), the same three approaches, if applied, would have given feed-back and feed-forward information. In actuality, there was no feed-back and minimum feed-forward. For example, at the Technical Design stage information obtained through project management from the feasibility studies should have shown very clearly the constructional and other problems of dealing with sub-surface solubles (i.e. the sink-hole problem). In turn this should have been fed forward to the Construction and Physical Implementation CPI Stage (IV) and back to PM.

The latter is especially important because the nature of the Construction and Physical Implementation contracts given by the PMB to (IV) - See Fig.9.1.C should be decided on advice received from Project Management, and the construction contractors should carry out work according to the exact specifications drawn up at the Technical Design Stage.

In actuality, the critical nature of this terrain factor was not fully recognised at the design stage and therefore ignored by the constructors. Similarly, with functional design. An essential requirement to meet the objectives was a body of skilled farmers and labourers. The minimal requirement could only be met by a training programme and this, in terms of critial path analysis, required operations in real time. Every operation should have been completed exactly within the planned time because their completion would give the green light for others to start.

Functional and Technical Design at Tauorga was in part a component of the Feasibility Study, all equivalent to Phase One of the project. When Phase Two, Stage One, Construction and Physical Implementation was to be carried out then Project Management was introduced, but this was given responsibility only for supervising construction. So the CPI (IV) became more or less a mechanical exercise carried out without reference to FTD (III) (except in terms of general engineering specification) and the Project Management (PM) itself was only concerned with civil engineering. Therefore there could be no adequate feedback or feed forward concerning the critical areas of operation, neither was there any body alerted to the need for integrating civil engineering sequences with e.g. land preparation or the training of potential settlers during the construction programme. In other words, the convergencies identified in critical path analysis and the interfaces between input factors were ignored.

So, the linkages shown in 9.1.C. could not be adequately used and by the end of the Construction and Physical Implementation (IV) the Production Phase (V) had to start almost from scratch (Fig. 9.1.D.). If Project Management had included agricultural as well as engineering responsibility the feedback and feed forward systems could have worked. In fact the PMB had to introduce a new Agricultural Management group (AM) which could only accept what had been done by CPI, and accept the bare outlines of project design from the earlier FS and FTD Stages.

In actuality the FS showed (but did not emphasize) the detailed characteristics required of Agricultural Management (AM), the degree of accuracy needs in soil/water management, the detailed programmes for training and educating settlers and maintenance labourers and the exceptional flexibility of importing. We can say that in terms of management input therefore, the law of the minimum was not met, poor feed back from FS to the PMB, and what made the situation worse was the minimal feed forward from PMB to the AM. These requirements were either ignored or not properly carried out by the AM which resulted in non-completion of the reclamatory cultivation stage. The latter together with the already uncompleted items such as the central village had formed a critical failure of critical path convergencies.

The national influences on the project such as those which change over time should also have been considered by the PMB in order to estimate to what extent they might affect the project and immediately to feed forward necessary instructions to the relevant agencies. In terms of critical path analysis in real time, the Tauorga project's PO and the methods of approaching them were first studied in 1960 and 1965 when Libya was a poor country, but changed considerably by 1972 when Libya had become very rich, and the construction phase should have finished; and had changed even more by 1974 when land preparation in Tauorga was beginning. What we see, in other words, is the hypothetical flow linkages of decisions and information as illustrated in Fig. 9.1 but an inadequate appreciation of what these flow processes could contribute and therefore the absence of any integrated appreciation of requirements at any level from the Policy Making Body to Agricultural Management. As a result the Production Phase was not completely attained and none of the main Policy Objectives reached.

In the Tawi Mileiha Development project case the PO laid out by the PMB was not as clear as the specific terms of reference would seem to imply. At no time was there a clear commitment to anything more than the construction and physical implementation necessary for the irrigation of 120 ha. of land. Socio-economic and the technical implications of this were not given serious consideration. In this project the potential demand for family holding and the minimal requirement of production labourers/settlers should have been fed forward to a relevant agency, before starting the project construction, in order to know whether to proceed or modify and proceed to the next step.

In actuality neither the settlers and their numbers were identified nor was any full investigation of the potential demand carried out because the PMB only slowly began to state further policy objectives after the hydrological survey and agricultural reconnaissance survey were carried out. These surveys, together with one more detailed layout survey, were assumed to constitute a Feasibility Study and provide sufficient Functional and Technical Design. The FS showed and emphasized the need for construction of perimeter and flood prevention barriers for the project protection; in other words the law of the minimum was satisfactorily identified in terms of this input and should have been fed forward to the PM by thh PMB.

But, in fact, this was deliberately ignored e.g. the perimeter was incompletely constructed and the flood prevention barriers were not constructed at all and resulted in a significant loss of land and therefore a decline in viability.

Thus the mere study of critical elements is insufficient; results of FS and information from FTD have to be practically applied.

Similarly the FS emphasized the need for very careful management of the physical factors, particularly in relation to water quality. This should have been considered very seriously by the PMB in order to appoint qualified and responsible Project Management and feed it with the recommendations from the FS.

In actuality the PM was not able to cope with the project construction requirements and the supervision team were not able to offer sufficient full time attention.

Additionally, it was not recognised that this project was being developed at a threshold of fundamental regional economic change over time. This in terms of critical path analysis in real time shows that this project which was valid when the first objective was stated in 1966, and could have been valid in 1968 when the project should have been in the production phase had to be seen very differently by the early 1970's when Dubai and Sharjah as well as Abu Dhabi had become oil producers.

In the Haradh project case we had seen that this project was abandoned as a settlement programme mainly due to the nomadic Bedouin attitudes, and this in terms of the law of the minimum could have been avoided if there had been a thorough investigation of this essential input factor. Thus the FS feed back to the PMB of the availability of settlers was hypothetically correct in terms of numbers of non-sedentary people but totally wrong in the assumption that they would wish to become involved in cultivation as permanent labourers.

Similarly, the market situation was not satisfactorily identified, thus the only outlet for the products was in Nejd and Hejaz in the centre and west, but the high transport costs have shown to have excluded profitability without the help of heavy government subsidy.

In terms of critical path analysis of the period between this project's conception and its readiness for a production phase, things which appeared feasible in 1966 such as the training of Bedouin for work on irrigated small holdings became practically impossible during the 1970's in the Eastern province of Saudi Arabia where opportunities for wellpaid employment off the land were very rapidly growing.

In the Al Hassa project case, while according to the FS feed back the PMB had taken a decision of reclaiming 12,000 ha. of cultivable land to give a total of 20,000 ha., it was later found that the total quantity of water available was in fact inadequate for the whole project reclamation. This in terms of the law of the minimum was an unsatisfactory identification of an essential input factor, mainly because the changes of demand over time were not appreciated. Again, critical path analysis emphasises the need for looking at development in real time. In this case, agricultural development in Al Hassa was paralleled by a growth in population (especially urban) in per capita domestic water demand, industrial and oilfield injection water demand.

The improved efficiency of water use required a technical rationalisation of the control of water quality and distribution from source to fields which in turn dictated a specific need for qualified and powerful management or advisory team; this was not identified by FS to feed back to the PMB. Unsatisfactory identification of these essential input factors, which consequently were either ignored or not properly prepared to converge with other operations at specific times, all failures led to problems and difficulties.

In the Qatif oasis case, we found that although the FS showed and emphasized the need for integrated drainage and irrigation systems, but still we can see that the law of the minimum was not satisfactorily met because there was no overcoming of the difficulty of introducing a structural network of drainage systems at all levels from field to oasis without which a proper soil/water balance everywhere would be impossible. In other words the FS should have showed the necessity of establishing, perhaps, several integrated drainage systems depending on topography, and this must consider the question of interdependence with the existing irrigation plots.

Furthermore, the inevitable technical requirement of qualified management to deal with these drains, irrigation water distribution which had to be extracted from multiple points, was not identified, and thus was not fed forward or backward.

By analysing these projects, one can say that in none of them had the production stage been satisfactorily reached and none of them realized its original objectives.

In all these cases we have shown, by examples, how, by the application of the analytical and evaluation approaches used in this thesis, considerable waste of capital could have been avoided and how agricultural development programmes could have been re-appraised and/or redesigned to achieve greater success. If we finally consider the proposed project in Oman it is possible to claim that, first, the decision whether or not to implement this project would be best taken by the processes of evaluation which we have used. Secondly, if the decision to proceed is taken for e.g. political rather than economic reasons, the same evaluation processes could be used to ensure the least wasteful or counter-productive results. It is suggested that approaches of this kind should be built into most if not all development projects.

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Appendix - A

Table of chemical water analysis (Tauorga Springs)

SAMPLE No.		A	B	2	3	4	5	6	7	8	9	11	13	14	15	17	50
Temperature ^{o}C.		31^{o}	32^{o}	20.5^{o}	18^{o}	-	20^{o}	30^{o}	34^{o}	-	20^{o}	-	21^{o}	21^{o}	22^{o}	39^{o}	-
Specific conductance micromhos at 25°C.		4200	-	5000	4200	4600	2700	2300	2700	5650	3350	5200	4600	6200	3740	-	5400
pH		7.4	6.95	7.2	7.4	7.2	7.3	7.0	7.4	7.0	7.0	7.0	7.0	7.0	7.0	6.65	7.0
Total hardness as $CaCO_3$	ppm	1333.8	1157	1469.2	1229.6	1578.6	708.6	781.5	890.9	1240	1042	1464	1448.4	1891.2	1026.4	1187	1995.4
Tot.diss.solids	ppm	2940.0	2790	3284	2680	3228.0	1720	1542	1700	3746	2250	3610	3458	4446.0	2510	3997	5170.0
SiO_2	ppm	24.0	-	24.0	16.0	8.0	2.0	14.0	32.0	16.0	12.0	8.0	8.0	14.0	6.0	-	18.0
Ca	ppm	292.0	292.0	298.0	250.0	330.0	152.0	154.0	182.0	258.0	194.0	266.0	262.0	358.0	184.0	292.0	424.0
Mg	ppm	147.1	104.0	176.3	147.1	183.4	80.3	96.1	106.3	144.7	135.0	194.6	193.3	242.0	137.4	104.0	227.4
Na	ppm	494.2	-	563.8	455.0	481.0	302.0	218.4	211.8	878.2	413.8	683.9	641.4	816.1	514.0	-	1033.8
K	ppm	32.8	-	32.8	37.5	29.7	52.4	46.9	45.0	65.7	16.4	41.0	32.8	40.7	32.8	-	48.9
HCO_3	ppm	296.5	103.0	263.5	568.5	214.7	222.0	353.8	268.4	716.0	178.5	147.6	191.5	244.0	219.6	143.0	231.8
CO_3	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CL	ppm	914.9	957.0	1007.0	836.9	858.1	439.7	361.7	432.6	1482.2	978.7	1198.4	1113.4	1446.8	1099.3	1880.0	1773.0
SO_4	ppm	864.1	811.0	1045.2	592.6	1221.3	539.9	493.8	538.2	539.9	420.5	1150.5	1116.8	1418.0	436.2	520.0	1552.2
NO_2	ppm	0.004	-	0.05	0.6	0.025	0.02	0.016	0.01	0.016	0.02	tr.	tr.	tr.	tr.	-	tr.
NO_3	ppm	20.7	-	11.5	13.8	13.8	20.7	tr.	20.7	tr.	tr.	8.0	8.0	8.0	tr.	-	17.2
Fe	ppm	tr.		tr.	tr.	tr.	tr.	tr.	tr.	-	-	-	-	-	-	-	-

Source:- Speetzen, H. Land Settlement Projects and Agricultural Development Unpublished Ph.D. Thesis, vol.II, part four, Department of Geog. (University of Durham, 1974), p.4.

SOIL CHEMICAL ANALYSIS

Hosha No.	pH+ (water)	E.C.+ mmhos	Salts %	$CaCO_3$ %	$CaSO_4$ %	Boron ppm	Organic matter %	SAR	ESP %
1	7.5	21.3	0.5	12.8	0.85	15.0	0.78	13.2	15.6
2	7.6	32.6	0.8	15.0	1.18	10.7	0.87	29.2	29.4
3	7.7	31.0	0.7	15.4	1.30	11.4	0.97	20.8	22.7
4	7.7	34.0	0.8	14.9	1.07	14.4	0.76	14.3	16.6
5	7.6	29.9	0.7	14.9	1.31	15.4	0.80	17.7	19.9
6	7.4	10.4	0.3	12.9	0.96	7.8	0.76	10.5	12.3
7	7.6	16.0	0.4	10.7	1.17	7.1	0.81	14.2	16.4
8	7.4	23.5	0.5	17.9	1.10	6.7	0.47	9.9	11.7
9	7.6	16.7	0.4	13.1	1.14	3.5	0.59	7.0	8.3
10	7.6	17.0	0.4	14.4	1.10	6.4	0.69	11.4	13.4
11	7.6	27.9	0.6	14.9	1.13	11.9	0.77	7.6	9.1
12	7.7	18.6	0.4	16.1	1.23	2.6	1.14	9.8	11.7
13	7.8	16.3	0.4	13.0	1.16	5.8	1.12	6.8	8.1
14	7.8	14.4	0.3	16.5	1.02	4.5	0.88	4.6	5.3
15	7.8	8.8	0.2	16.5	0.91	4.2	1.08	6.7	7.9
16	7.8	4.5	0.1	16.5	0.10	3.6	0.89	7.6	9.0
17	7.8	4.3	0.1	16.9	0.08	2.8	0.79	6.0	7.1
18	7.6	21.8	0.5	17.3	1.02	6.9	0.60	13.5	15.7
19	7.4	16.3	0.4	14.0	1.06	8.2	0.36	13.5	15.7
20	7.5	23.2	0.5	15.4	1.06	16.2	0.50	26.0	27.1
21	7.6	32.4	0.7	14.8	1.11	24.5	0.36	27.6	28.3
22	7.6	25.1	0.5	14.8	1.28	8.6	0.33	20.0	22.1
23	7.6	38.4	0.8	15.6	1.39	18.5	0.47	26.0	27.0
24	7.5	15.7	0.3	15.7	1.01	7.7	0.40	20.2	22.2
25	7.6	14.9	0.3	15.8	0.70	20.7	0.47	6.7	7.9
26	7.5	8.4	0.2	15.8	0.97	2.3	0.43	6.5	7.7
27	7.7	9.4	0.2	17.9	0.95	3.8	0.29	4.6	5.2
28	7.4	5.8	0.1	18.1	0.75	5.5	0.30	4.6	5.2
29	7.6	26.6	0.6	8.9	1.15	18.6	0.68	22.1	23.8
30	7.5	9.5	0.2	8.6	0.94	9.1	0.71	20.1	22.1
31	7.5	15.2	0.4	12.9	0.94	10.8	0.52	17.3	19.5
32	7.5	12.4	0.3	11.5	0.98	24.8	0.70	35.9	34.1

* in saturation extract

Source: Final Report - Supervision of the Tauorga Agrarian Reform Project - Second phase, WAKUTI (Siegen, March 1977) p.20.

Appendix - B2

SOIL CHEMICAL ANALYSIS

Hosha No	Cations ME Q/L Na+	K+	Ca++	Mg++	Total	Anions ME Q/L HCO_3^-	Cl^-	SO_4^{--}	Total	Saturation %
1	66.2	4.5	28.5	21.6	120.8	4.0	77.6	38.7	120.3	34
2	156.0	6.8	29.5	27.7	220.0	3.1	160.3	56.0	219.4	36
3	99.7	4.7	24.6	21.5	150.5	2.8	104.4	51.2	158.4	36
4	67.0	3.6	25.1	18.6	114.3	2.7	69.6	41.6	113.9	37
5	86.6	5.1	27.7	20.2	139.6	2.4	87.2	50.5	140.1	35
6	45.7	2.8	22.8	15.2	86.5	3.2	49.4	33.7	86.3	38
7	62.6	3.2	20.8	16.9	103.5	3.1	66.2	34.6	103.9	40
8	47.5	2.7	30.9	15.4	96.5	4.6	63.5	29.0	97.1	35
9	31.1	2.7	26.6	12.8	73.2	4.1	37.4	32.2	73.7	36
10	51.7	3.4	24.3	17.1	96.5	3.1	58.5	35.0	96.6	35
11	32.5	2.8	23.6	12.6	71.5	2.9	37.1	31.8	71.8	36
12	53.0	3.6	37.9	20.3	114.8	8.1	68.6	37.1	113.8	36
13	32.8	2.7	30.8	15.3	81.6	7.4	40.8	32.9	81.1	36
14	20.4	2.7	25.7	13.0	61.8	6.6	31.2	23.1	60.9	34
15	30.3	2.9	26.4	14.7	74.3	5.8	39.8	29.2	74.8	38
16	24.2	2.4	19.5	11.2	57.3	5.0	27.6	23.9	56.5	37
17	22.3	1.8	17.3	10.0	51.4	4.1	26.7	20.6	51.4	36
18	60.6	4.4	24.1	16.5	105.6	3.4	65.0	36.8	105.2	37
19	59.8	3.0	25.5	14.8	103.1	2.9	73.4	29.1	105.4	35
20	109.1	9.6	30.5	23.4	172.6	3.8	114.2	63.2	181.2	34
21	152.4	7.8	30.2	30.9	221.3	3.8	144.7	66.0	214.5	33
22	94.0	4.9	24.1	20.0	143.0	2.7	96.4	44.9	144.0	31
23	140.8	6.4	26.2	33.1	206.5	3.1	153.0	54.8	210.9	33
24	92.6	6.2	26.3	17.8	142.9	3.4	98.3	41.6	143.3	33
25	26.5	2.2	19.6	11.6	59.9	4.9	28.6	26.2	59.7	31
26	32.6	2.6	28.7	21.2	85.1	5.8	43.1	36.6	85.5	31
27	16.7	1.9	16.2	10.6	45.4	4.0	18.6	22.2	44.8	31
28	16.5	1.8	16.7	10.4	45.4	7.0	19.2	18.6	44.8	32
29	112.9	6.1	26.9	25.5	171.4	3.8	120.2	46.3	170.3	38
30	100.5	5.4	25.4	22.2	153.5	2.8	109.3	48.3	160.4	38
31	85.9	4.4	26.3	23.3	139.9	2.6	94.6	43.5	140.7	38
32	186.5	6.9	26.2	27.8	247.4	2.7	174.1	54.9	231.7	37

Source: Final Report - Supervision of the Tauorga Agrarian Reform Project - Second phase, WAKUTI (Siegen, March 1977) p.21.

Appendix - B3

SOIL MECHANICAL ANALYSIS

Hosha No	Depth cm	Clay %	Silt %	Sand %	Texture	Water capacity %	Infilt.+ rate cm/hour	Pore volume %
1	28.9	12.3	30.8	56.9	SL	25.4	2.2	45.8
2	28.2	12.4	33.6	54.0	SL	32.4	1.9	46.8
3	28.0	12.9	36.8	50.3	L	25.7	2.5	44.8
4	29.5	12.9	38.7	48.4	L	31.3	2.5	49.0
5	28.8	11.4	37.1	51.5	L	33.7	3.5	47.6
6	27.8	12.4	35.3	52.3	SL/L	33.4	1.6	44.2
7	28.3	12.0	36.4	51.6	L	29.0	2.0	37.3
8	23.8	11.2	30.4	58.4	SL	21.9	2.3	36.8
9	27.5	12.2	36.5	51.3	L	34.9	1.1	37.2
10	25.5	11.7	39.2	49.1	L	38.7	7.7	44.2
11	26.9	12.4	37.3	50.3	L	35.3	2.3	45.7
12	28.6	13.7	35.8	50.5	L	38.1	3.5	47.9
13	27.3	10.3	31.6	58.1	SL	32.1	4.7	46.6
14	26.1	11.8	23.3	64.9	SL	19.1	3.1	38.1
15	29.1	14.6	24.6	60.8	SL	26.7	7.1	45.0
16	30.0	25.9	17.9	56.2	SCL	32.6	3.8	46.2
17	30.0	20.4	14.6	65.0	SCL	18.9	0.8	27.2
18	25.0	11.9	34.0	54.1	SL	34.8	1.6	44.7
19	23.0	11.5	29.5	59.0	SL	33.9	2.8	47.7
20	24.0	11.1	27.6	61.3	SL	34.5	2.1	46.0
21	24.0	14.9	30.1	55.0	SL	39.7	2.5	51.0
22	27.0	12.2	28.0	59.8	SL	30.0	3.5	45.4
23	24.0	14.5	26.7	58.8	SL	39.3	0.7	38.7
24	26.8	13.5	21.4	65.1	SL	40.6	1.6	39.5
25	26.0	10.1	17.1	72.8	SL	39.7	1.4	36.9
26	29.6	10.1	9.3	80.6	LS	9.9	5.5	33.9
27	29.3	12.2	6.8	81.0	LS/SL	13.4	3.7	44.9
28	30.0	13.9	10.6	75.5	SL	16.9	1.4	41.7
29	22.0	12.7	11.8	75.5	SL	37.6	1.3	35.1
30	24.0	10.5	18.2	71.3	SL	30.7	1.8	46.5
31	24.0	10.7	21.6	67.7	SL	36.9	1.5	52.5
32	23.0	9.9	19.0	71.1	SL	35.6	1.8	45.0

+ Average during six hours SL = Sandy Loam SL/L = Sandy Loam/Loam
LS/SL = Loamy Sand/Sandy Loam LS = Loamy Sand L = Loam
SCL = Sandy Clay Loam

Source: Final Report - Supervision of the Tauorga Agrarian Reform Project - Second phase, WAKUTI (Siegen, March 1977), p.17.

Appendix - C

Yield decrement to be expected for certain crops due to salinity of irrigation water when common surface methods are used

CROP	0%			10%			25%			50%			Maximum
	ECe	ECw	TDS	ECe	ECw	TDS	ECe	ECw	TDS	ECe	ECw	TDS	ECdw
Barley	8	5.3	3,392	12	8	5,120	16	10.7	6,848	18	12	7,680	44
Wheat	4.7*	3.1	1,984	7*	4.7	3,008	10	6.7	4,288	14	9.3	5,952	40
Sorghum	4	2.7	1,728	6	4	2,560	9	6	3,840	12	8	5,120	36
Maize	3.3	2.2	1,408	5	3.3	2,112	6	4	2,560	7	4.7	3,008	18
Broadbean	2.3	1.5	960	3.5	2.3	1,472	4.5	3	1,920	6.5	4.3	2,752	18
Beans (field)	1	0.7	448	1.5	1	640	2	1.3	832	3.5	2.3	1,472	12
Tomato	2.7	1.8	1,152	4	2.7	1,728	6.5	4.3	2,752	8	5.3	3,392	22
Potato	1.7	1.1	704	2.5	1.7	1,088	4	2.7	1,728	6	4	2,560	20
Onion	1.3	0.9	576	2	1.3	832	3.5	2.3	1,472	4	2.7	1,728	12
Watermelon	2	1.3	832										
Alfalfa	2	1.3	832	3	2	1,280	5	3.3	2,112	8	5.3	3,392	28
Olive	2.7	1.8	1,152	4.6	2.7	1,728				9	6	3,840	28
Pomegranate	4	2.7	1,728	4.6	4	2,560				9	6	3,840	28
Orange	1.7	1.1	704	2.5	1.7	1,088				5	3.3	2,112	16
Lemon	1.7	1.1	704	2.5	1.7	1,088				5	3.3	2,112	16
Grape	2.7	1.8	1,152	4	2.7	1,728				8	5.3	3,392	24
Almond	1.7	1.1	704	2.5	1.7	1,088				5	3.3	2,112	16

Source:- USDA - Agr.Inf.Bull. 283, (California, nd.)

ECe means electrical conductivity of saturation extract in millimhos per centimetre (mmho/cm) : ECw means electrical conductivity of irrigation water (in mmho/cm). TDS as shown = ECw x 640. ECdw show maximum concentration of salts in drainage water permissible for growth. Use to calculate leaching requirement (LR = ECw/ECdw x 100 = %) to maintain needed ECe in active root area : Leaching Requirement (LR) means that fraction of the irrigation water that must be leached through the active root zone to control soil salinity at a specific level.

* Tolerance during early seeding stage (wheat and barley) is limited to ECe about 4 mmho/cm.

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